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ARMY RD&A

SEPTEMBER - OCTOBER 1998

An Exclusive Interview With The Army's Chief Information Officer

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- Implementing Force XXI

LTG WILLIAM H. CAMPBELL

FROM THE ARMY ACQUISITION EXECUTIVE

The Digital Battlespace

This is an exciting time to be a part of America's Army. We are the world's premier land combat force. With great skill and precision, our soldiers operate the most technologically advanced weapon systems available. We are hard at work upgrading those systems and introducing new "leap-ahead" systems to maintain our combat overmatch. And we are working to give our soldiers the essential ingredient they will need to dominate the future battlespace: information dominance.

Desert Storm taught us that, to truly dominate the future battlespace, we will need more than the best soldiers and the best weapons. We will need to achieve and maintain information dominance. Information is power, and the key to that power is the capability to securely collect, process, disseminate, and use information about the enemy while preventing him from obtaining similar information about us. If our soldiers and leaders at all echelons are making informed decisions based on a common picture of the battlespace while the enemy is guessing based on incomplete or erroneous information, we dominate the battle. Digitizing the force is absolutely critical to making information dominance a reality.

Digitization is the application of information technologies to Army battlefield operating systems so our soldiers and leaders can acquire, exchange, and employ timely information throughout the battlespace. This information can be tailored to the needs of the individual decisionmaker: commander, shooter, and supporter. It will allow each to maintain a clear and accurate picture of the battlespace to support both the planning and execution phases of military operations. Digitization will enable the warfighter to communicate vital battlefield information instantly and reliably, horizontally and vertically.

A digitally networked Army will provide a fully integrated command and control capability—from the strategic level, to the platform level, to the individual infantry soldier—linking joint and multinational forces. Digitally networked communications will revolutionize the battlespace through high-speed data exchange, and rapid correlation, fusion, and display of a variety of information to commanders at all levels. This will result in unsurpassed operational flexibility throughout the entire spectrum of military operations.

Digitization has many advantages. First, it is a cost-effective force multiplier. Second, it provides a significant increase in the ability of commanders and leaders at all levels to quickly synchronize combat power. Third, it provides timely and accurate information on friendly force locations, thus reducing the potential for fratricide.

Throughout history, the fog of war has prevented soldiers from finding the answers to three critical questions: Where am I? Where are my friends? Where is the enemy? Technology now offers soldiers a way to pierce the fog of war and answer these questions. This shared situational awareness greatly increases combat force lethality and survivability.

Since 1994, the Army has tested the value of digitized forces in a series of advanced warfighting experiments (AWEs). A typical AWE might pit a digitized Blue Force with networked digital equipment against a Red Force with traditional platforms. The AWE data confirm that when properly used, secure information technology creates an order of magnitude improvement in combat effectiveness. To capitalize on the compelling military advantage of digitization, we will field the First Digitized Division, the 4th Infantry Division at Fort Hood, TX, by the year 2000. By 2004, we expect to field the III Corps at Fort Hood as the Army's First Digitized Corps.

The First Digitized Division will be equipped with a mix of legacy and early design digital systems. Many of these systems are in the field today. Others are already slated for fielding as part of the normal modernization process. We will remanufacture some of our current systems to build in digital capability, add or "appliqué" a capability to others, and design open architecture information capabilities for future systems.

For example, through an information technology insertion approach, we are integrating digital and advanced infrared sensors into Abrams tanks and Bradley Fighting Vehicles. The Longbow Apache's leap-ahead target acquisition system, fire-and-forget HELLFIRE missiles, and advanced digital processors and communications will provide a truly coordinated rapid-fire capability to the maneuver force commander 24-hours-a-day in all weather conditions. In addition, all systems will digitally link with Scout helicopters and artillery fire direction centers, transmitting data directly to command and control vehicles and to Army Battle Command System components.

As recent events have shown, the very nature of the world and of warfare have changed. We are redesigning America's Army to reflect the challenges of the current and projected world environment and to take full advantage of technological advances. Maximizing operational capability in the digital battlespace is our highest priority.

Paul J. Hoeper

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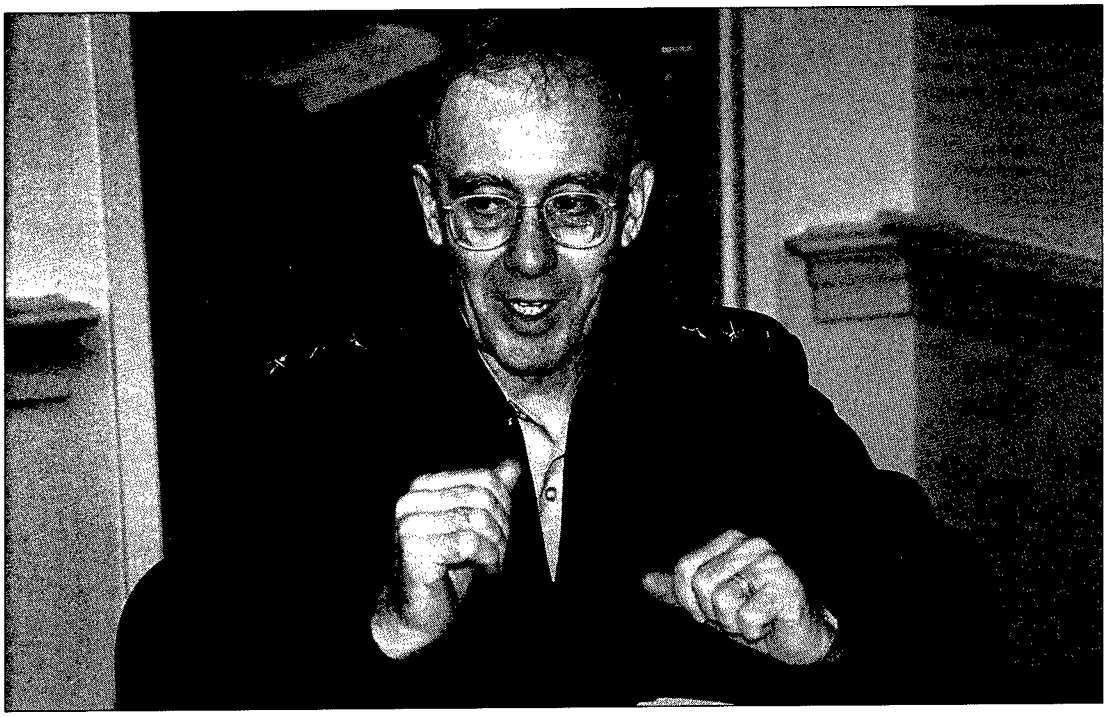
FEATURES

DEPARTMENTS

COVER

LTG William H. Campbell, Director of Information Systems for Command, Control, Communications and Computers, responded to a range of questions from the Editor-In-Chief of *Army RD&A*. Topics included the Y2K problem, Army Enterprise XXI, and digitization.



INTERVIEW WITH LTG WILLIAM H. CAMPBELL DIRECTOR OF INFORMATION SYSTEMS FOR COMMAND, CONTROL, COMMUNICATIONS AND COMPUTERS (DISC4)

Q. What are your top priorities as the DISC4?
A. My top priorities are digitizing the battlefield, fixing the year 2000 problem, and information assurance. There are many other critical tasks, but these are the top three. Failure in any of these areas would have a serious impact on the Army's current and future readiness.

Q. How does the year 2000 problem affect weapon systems? Isn't this largely an information systems issue?
A. I'm glad you asked. The Y2K problem affects virtually all, repeat, all weapon systems. Any PM or agency responsible for a system with embedded microprocessors (and that's probably all systems fielded today) has a potential problem. I've heard some people say, "My system processes real-time data measured in nanoseconds, not decades or centuries, so Y2K isn't a problem for me." That's the wrong answer. That real-time system may not function at all after Dec. 31, 1999, if its black boxes have embedded chips that are not Y2K compliant. These processors are ubiquitous. They are in subtle places like controllers, uninterrupted power supplies, and preflight equipment, for example, not just in the obvious components like mission control computers. Any PM who is not aggressively checking the total system for potential Y2K problems is at grave risk of failure. To address this problem in our warfighting forces, the Joint Staff is planning to test weapon systems in a series of CINC [commander-in-chief] exercises during the next 18 months. The plans include Army systems that will be evaluated in a simulated year 2000 timeframe. Finding and fixing Y2K problems is job number 1 for all of us. That's not just my view—it's policy guidance from the Army Chief of Staff and the Secretary of the Army.

Q. Can you explain Army Enterprise XXI?
A. It's all about extending the "information superhighway" throughout the Army. Enterprise XXI is the Army's overarching plan to build a secure, seamless information network. It is the foundation for achieving information superiority, the organizing principle for Joint Vision 2010 and Army Vision 2010. It will enable battlefield interoperability, network-centric warfare, and linkage to the sustaining base and infrastructure. It is also the enabler for business process reengineering in virtually all functional areas. To be a world-class

Army in the information age, we must continue to leverage the exploding information technology in the commercial sector and implement best business practices. Enterprise XXI is our vision for making that happen.

Q. Could you describe what the digital battlefield is and what the Army hopes to achieve with it?
A. Digitizing the battlefield is the application of information technologies to acquire, exchange, and employ timely digital information throughout the battlespace, tailored to the needs of each commander, shooter, and supporter. It provides soldiers at all levels near real-time situational awareness that answers the questions: "Where am I?," "Where is my buddy?," and "Where is the enemy?" It links sensors to our shooters. The digitization program is our effort to maximize the potential of our warfighting systems by providing the means to synchronize firepower and maneuver with logistics and command and control. It gives us the edge by getting everyone into the fight and allowing us to operate inside the enemy's decision cycle.

Enterprise XXI is the Army's overarching plan to build a secure, seamless information network.

Q. How is the Army addressing some of the Congressional concerns relative to the digital battlefield?
A. The Army has submitted a budget that seeks to balance force structure, readiness, and modernization within our budget authority. The budget supports Army plans to equip the First Digitized Division by the end of fiscal year 2000 and the First Digitized Corps by the end of fiscal year 2004. Successfully accomplishing this complex task *requires the balanced and synchronized fielding* of numerous items of equipment, including C3I [command, control, communications and intelligence] systems and digital components of weapon systems. We are meeting with members of Congress and their staffers to tell the Army story and defend our programs. It's important to note that the Army has rolled over 500 budget lines into its digitization program, so it's much more than just C3I.

Q. You have stated previously that one of the best ways to advance the Army's information technology efforts is to tap into the vast pool of knowledge and experience that exists in the commercial marketplace. How do you plan to go about doing this?
A. We have some very talented military and civilian information technology professionals in the Army, but we acquire information technology from the commercial marketplace. To stay ahead of the power curve, we have cooperative research and development agreements with industry. We work with industry and academia to import the best business practices and lessons emerging in the commercial sector. We also partner with industry in the Central Technical Support Facility at Fort Hood, TX. This offers our industrial partners the opportunity to gain insight into the Army's characteristics and requirements, and it keeps us current with industry's products. It's a two-way street.

Digitizing the battlefield is the application of information technologies to acquire, exchange, and employ timely digital information throughout the battlespace, tailored to the needs of each commander, shooter and supporter.

Q. How is the Army managing the Year 2000 software problem?

A. Y2K is a leadership and management issue, not just a technical matter. Our approach is centralized policy and decentralized execution of a five-phase correction process. The phases are awareness, assessment, renovation, validation and implementation. HQDA monitors progress and reports to the Office of the Secretary of Defense. At this time, most systems are in the renovation phase. We use the Army Audit Agency, the IG [Inspector General] system, and our Y2K workforce to conduct periodic reviews to track progress and provide assistance. We are focusing our efforts in every domain, from weapon systems, to administrative and logistical systems, to the embedded devices that exist throughout our infrastructure (for example, heating and air conditioning systems, elevators, and security systems). We have established Y2K web pages as a means to aggregate information from industry and government on what works, what doesn't, and industry's plan for fixing their products so that we are aware across the Army of where potential problems exist and how to fix them.

Q. The Army's heavy emphasis on information technology obviously presents some major challenges with regard to protecting important information. Can you comment on the Army's efforts in development of an information security system architecture?

A. The Army's Network Security Improvement Program provides for defense in depth. It includes intrusion detection systems, firewalls, cryptographic equipment, and online monitoring of systems connected to the Internet. It also involves training of system administrators and users as well as "red teams" that assess vulnerabilities of our tactical systems and administrative systems. We know that there are serious vulnerabilities in networked systems. We have been "hacked." We have gotten several wakeup calls. We are working aggressively to protect our information systems. This is all about force protection, so we're building security into all of our systems and networks.

Q. What is meant by "paperless acquisition" and "paperless contracting," and what are your thoughts on these two concepts?

A. Paperless acquisition is a concept that encompasses the Army's entire acquisition process including requirements definition, development, fielding, maintenance, and disposal of systems, as well as procuring supplies and services for use at Army installations. It will include electronic commerce practices from industry. The Army's paperless acquisition system will enable us to conduct all contracting transactions digitally. By the year 2000, the Standard Procurement System will be fielded to 239 sites in the Army. The Joint Computer Aided Logistics System is being fielded now. Together, these systems will deliver the full complement of paperless contracting capabilities. This will reduce acquisition lead time, streamline the process, and yield dollar and manpower savings to the Army.

Q. Another very hot topic in the Army's acquisition community is "spiral development." What is this and what role do you expect it to play in the information technology arena?

A. The traditional "waterfall" development paradigm is not a viable method for developing information systems. It just takes too long and often delivers obsolete solutions. With changes in information technology occurring every 18 to 24 months, materiel developers need a more agile process to acquire newer technology. The term "spiral development" is really an adaptation of a methodology introduced years ago in the software development community. The spiral development paradigm allows us to evolve the requirement process (firmer definition as a function of time) while at the same time delivering usable functionality to the field. Instead of taking years to deliver "grand design" solutions, PMs provide incremental products in a relatively short cycle with the users in the loop. The result is continuous process improvement and continual upgrades to our warfighting systems. The imperative is for us to give our soldiers an advantage over all opponents they might face on the battlefield, and we can't do that in the information age unless we continuously improve our fielded systems. It's a journey, not a destination.

FIRST DIGITIZED DIVISION IMPLEMENTATION

BG Steven Boutelle and
Charles Pizzutelli

Introduction

The term "revolution in military affairs" (RMA) is used to convey the magnitude of changes that the Army is undertaking. Leading the doctrinal and organizational changes of the RMA is the digitization of the battlefield through fielding of the Army Battle Command System (ABCS). Fielding of the ABCS to the First Digitized Division (FDD) is a major milestone (Figure 1) in a continuum of activities that will evolve the Army of today through Army XXI to the Army After Next. The Program Executive Office for Command, Control, and Communications Systems (PEO-C3S) is responsible for the development, integration, and fielding of the automated systems that are critical for implementing the FDD.

While the FDD appears to be just another event on the road to Army XXI, it presents challenges that dwarf earlier events. Unlike its predecessors (Task Force XXI and the Division Advanced Warfighting Experiment (DAWE)), FDD will be a fielding. Each system must satisfy the requirements for materiel release, and the entire integrated capability must be warfightable, trainable and sustainable. These aspects were barely considerations in the earlier experiment-oriented events.

The second challenge is the enormity of the event. During the 27-month period ending in September 2000, more than 100 separate systems consisting of more than 10,000 pieces of associated equipment will be fielded to the FDD. Again, these numbers greatly exceed those previously experienced.

The overall orchestration of the FDD enterprise may well be the most significant challenge. From the materiel viewpoint, FDD involves most of the Army's program executive offices and the various major subordinate commands of the Army Materiel Command, all of which must work together with a single purpose. Delivery of the many systems must be fully coordinated with the gaining unit's extremely busy training schedule. Schedule management is vital as even a seemingly minor change to an individual system schedule may significantly alter the overall schedule.

FDD Schedule

The Program Executive Officer and his Project and Product Managers implemented a logical and iterative process to meet the FDD schedule and operational requirements. Some of the major tasks that the PEO undertook to support the FDD include requirements synchronization, rapidly incorporating new functions and technologies, integrating and testing of the FDD systems and architectures, and the training of personnel. Interim "checkpoints," called synchronization events, were incorporated into the FDD schedule to allow the PEO and the unit to verify progress at key points. Figure 2 depicts these synchronization events and supporting activities dealing with the development of Tactical Operations Centers (TOCs), the release of software upgrades, and fielding.

System Requirements

System requirements have historically been defined from a vertical perspective. The FDD, however, required developers to adopt a horizontal perspective and address questions dealing with information exchange between ABCS subsystems. Several major efforts were undertaken to ensure that the ABCS suite of equipment provided optimal horizontal capabilities for the unit.

Defining the Architectures. Working with the U.S. Army Training and Doctrine

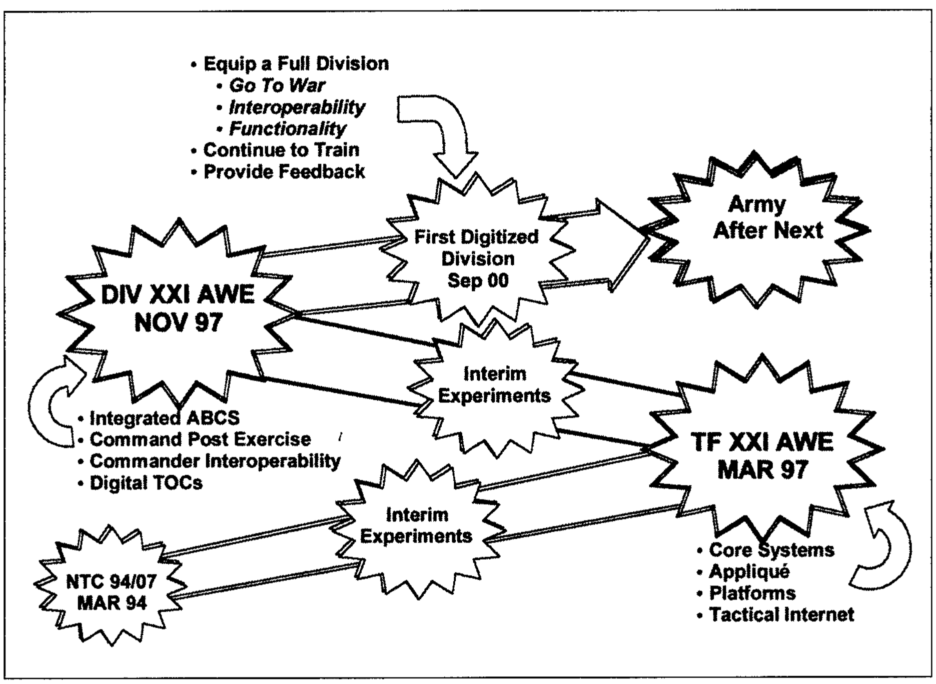


Figure 1.
The path to force digitization.

Command and other user representatives, the PEO defined what the FDD would "look like" within the contexts of a system and an operational architecture. Preliminary equipment allocations were determined for each location and discussions were held to ensure that the operational architecture properly reflected user desires. The PEO also helped to evolve the operational architecture into the FDD system architecture. The system architecture defines the information flow so that information can be sent to the locations and systems that require it. The system architecture also defines what each computer must do with a message it receives (e.g., store, portray, process to generate other information, and/or retransmit to another location).

Defining the Technical Requirements. To ensure interoperability, DOD and HQDA mandated technical standards that govern how systems are built. These include developing an overarching architecture framework and ensuring compliance with the Defense information infrastructure common operating environment (DII COE), Joint Technical Architecture-Army (JTA-A), and Year 2000 (Y2K) mandates. While transparent to users, these standards must be technically uniform. Additionally, the schedules for attaining standards compliance must be synchronized for all systems; failure would result in a loss of interoperability among systems. As such, the PEO has ensured that all ABCS subsystems will achieve a common level of DII COE compliance, conform to the JTA-A standards, and be Y2K certified prior to FDD fielding.

Data Standardization and the Common Operational Picture (COP). "Seeing the battlefield" requires that a commander and his or her staff be able to access any ABCS workstation, define variables (area of operations, coordination measures, unit types, etc.), and see a common graphic portrayal of the relevant battlefield information elements. To provide this ability, the PEO led an effort that defined the COP and verified that the information was available within the ABCS. Once the data in the ABCS was verified, the challenge was to make the data available to everyone. The method of implementation is the ABCS common database (ACDB).

The ACDB consists of standardized data elements that are common to two or more ABCS subsystems, in a relational database. The ACDB is fully integrated and includes a common set of tables, fields, domains, keys and relationships, and data distribution mechanism. The ACDB will also be completely integrated with the DII COE Common Message Processor, in terms of autofill and autopost capabilities.

Figure 3 depicts the relationship

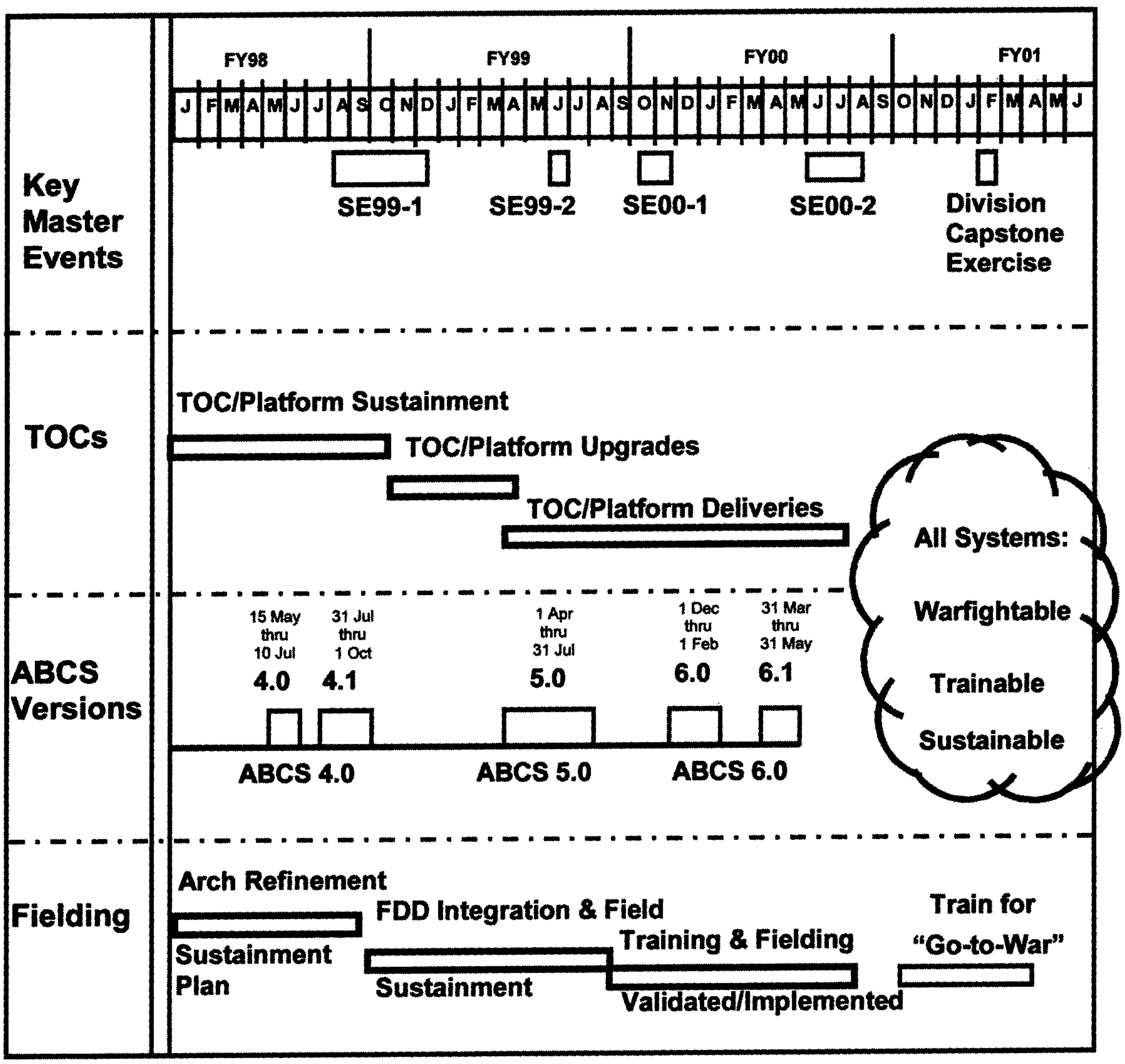


Figure 2.
Master First Digitized Division schedule with internal milestones.

between the ACDB and the other system components that are required for the exchange of information throughout the First Digitized Division. Each ABCS subsystem has a battlefield functional area (BFA) unique database and an ACDB. The former is used to store system-unique information. ACDB implementation is identical, in structure and content, across all the BFAs and is used to maintain and store information that is common to two or more ABCS subsystems. Each BFA updates its ACDB as the information in its system database is updated. ABCS data distribution mechanisms then disseminate this information to the ACDBs resident in other systems. Once received by the ACDB, the new information is used to update the COP and support the conduct of unit operations.

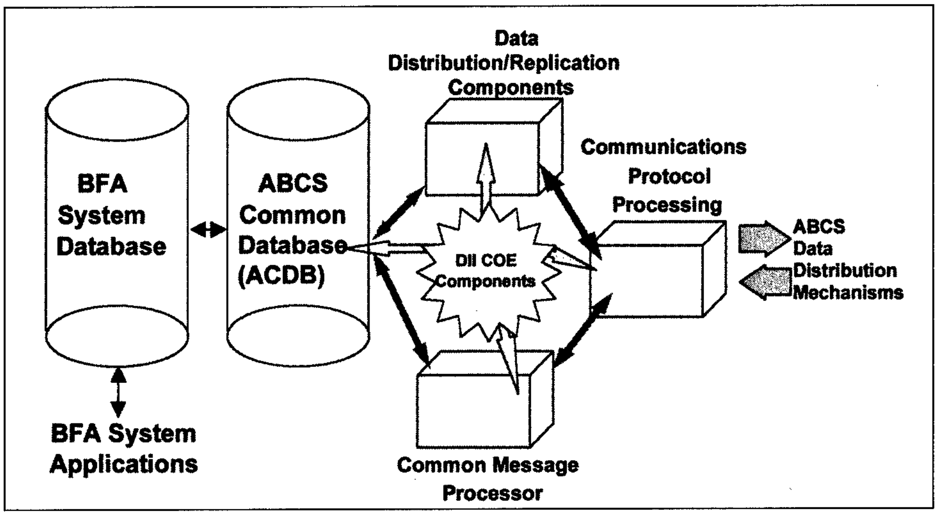


Figure 3.
The ABCS common database is the basis for data standardization and information transfer.

Spiral Development

Building on experience with earlier exercises, the PEO expanded the role of the spiral development process in engineering for the FDD. A key point of this process is that it allows greater flexibility in injecting new and updated requirements into the development process. This means the field user can provide feedback (from exercises or other activities) to incorporate into the system baseline and influence future versions of the system. Ultimately, the soldier will receive newer technologies more quickly.

System Integration And Testing

A key element of successful system test and integration is the use of a specialized test facility, the Central Technical Support Facility (CTSF). The CTSF enables rapid integration of dissimilar hardware and software systems through the real-time interaction of soldiers, developers, testers, program managers, and requirements personnel. The CTSF expedites evaluation of software releases for interoperability, software replication, and software configuration management, and it provides a validated baseline for system testing and integration. The CTSF staff also supports onsite training and the exercise of tactics, techniques and procedures and battle drills with soldiers in the loop. The facility is located at Fort Hood, TX, and has proven its merit during both Task Force XXI and the DAWE.

Training

A major lesson learned from prior advanced warfighting experiments and fieldings is the criticality of ABCS sustainment training. Recognizing that the Service schools are working to integrate an ABCS component into their training programs of instruction, the PEO took the lead in providing the FDD with an interim "stay-behind" capability. The first product of this is the reconfigurable TOC within the CTSF. Equipped to resemble all of the individual cells of a TOC at multiple echelons, this facility enables the progression from development through testing and training without the scheduling nightmares associated with deployments, setups and teardowns. A capability is also being provided for multiple tactical vehicles to drive up and connect to the TOC's local area network (LAN), thus expanding the number of users and systems participating in the testing or training. Additionally, the PEO-C3S continues to refine training materials, techniques, and methods for accomplishing collective training for the commanders and battle staffs. Facility completion is scheduled for the first quarter of FY99.

Knowledge Center

The nature of the First Digitized Division requires continued flexibility and innovation as the PEO seeks the optimal means for incorporating new technologies and capabilities and addressing increasingly refined requirements. A PEO-C3S Knowledge Center (**peoc3s1.monmouth.army.mil**) has been established as the means of disseminating information to the Army community and keeping it apprised of the most recent plans and schedules. This website contains information on the PEO organization, schedules, calendars, and related FDD activities, from architectures through implementation plans. This site also provides information on the specific programs under the PEO-C3S organization.

Conclusion

The introduction of an ABCS impacts every aspect of unit operations—from the way the commander thinks and operates to the functioning of the staff, the role of the noncommissioned officers, and the deployment of the subordinate units. The equipping of the FDD will provide, at division level, a truly new and innovative capability. With that "newness" comes unique and challenging requirements in defining and sustaining architectures, standardizing procedures and equipment utilizations, training, and maintenance. The equipping of the FDD will be both a milestone in the Army's migration to the Army After Next and a start point for the next step in that migration—the First Digitized Corps.

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ARMY BATTLE COMMAND SYSTEM

Keystone To The First Digitized Division

BG Steven Boutelle and
Charles Pizzutelli

Introduction

The Army Battle Command System (ABCS) is a complex system of systems that links automation assets, communications media, and operational facilities to provide commanders and their staffs the ability to collect and analyze information, develop plans and orders, and monitor the tactical battlefield while simultaneously planning future operations. While providing these capabilities to the ground forces, ABCS also plays a central role in linking the Army to the Global Command and Control System (GCCS). As such, it provides the mechanism to receive and transmit information among the joint forces.

ABCS Subsystems

As the Army's component in GCCS, ABCS consists of an array of subsystems for the Battlefield Functional Area (BFA) that each supports, provides information to share with other systems, and provides situational awareness of the battlefield. In addition, ABCS subsystems provide an array of specialized capabilities and applications for commanders of diverse units at all levels. The accompanying table shows the ABCS subsystems and describes their functions.

While the First Digitized Division (FDD) marks a quantum leap forward in the synchronized fielding of ABCS equipment and capabilities to one location, it also builds on the earlier fielding of several other ABCS subsystems to tactical units around the world. At the system level, ABCS provides horizontal interoperability and information transfer capabilities for these subsystems. It is the glue that enables the commander to "see the battle."

ABCS Enhancements

A significant software development and integration effort is ongoing to enhance ABCS as it evolves from its current 4.0 baseline. Two major ABCS software releases are planned for the FDD timeframe. Version 5.0 in 1999 will provide new and enhanced capabilities while version 6.0 in 2000, the FDD objective system, will be the first true "go-to-war" package.

Software Architecture. Software architecture enhancements in ABCS version 5.0 focus on finalizing ABCS server allocation, optimizing client server operations, integrating Embedded Battle Command (EBC) to achieve interoperability with lower echelon systems, and providing the initial Common Tactical Picture capability. Version 6.0 focuses on continuity of operations and other aspects resulting in an ABCS that is warfightable, trainable and sustainable.

EBC-ABCS Integration. The objective of this effort is to ensure that Force Battle Command Brigade and Below applications/systems and EBC/ABCS applications/subsystems can exchange Joint Variable Message Format (JVMF) messages. Both multicast and unicast JVMF message exchange capabilities will be included in ABCS version 5.0. By April 1, 1999, other enhancements will include Y2K fixes and implementation of a communications message processor. ABCS version 6.0 will include additional improvements with the ultimate goal of centralizing EBC/ABCS functions into a multitiered software architecture. The schedule for these efforts is addressed in the article "First Digitized Division Implementation" on Page 5 of this magazine.

Communications Media

The movement of large quantities of digital information across the battlefield places enormous demand on the radio bandwidth available in the tactical environment. While the use of techniques such as bit-oriented messages and data compression increase efficiency of the electronic spectrum, they alone will not provide the flexibility and effectiveness required of our communications architecture. Consequently, the FDD will employ the Warfighter Information Network (WIN) for communications.

Two of the major components of WIN are the tactical Internet (TI) and the WIN-Terrestrial (WIN-T). Within the WIN architecture, the TI is used at brigade and below, and at mobile entities at higher headquarters that use the Single Channel Ground Airborne Radio System or the Enhanced Position Location Radio System for data exchange. The WIN-T provides long-haul capabilities at division and higher headquarters. The WIN system is similar to the Internet used on home PCs. The operator simply enters the destination(s) for traffic and transmits it without having to switch frequencies or worry about the type of transmitter.

Similar to the commercial Internet, the WIN infrastructure will resolve these issues and swiftly transmit the information to its proper destination.

Several improvements are being made relative to the WIN. In fact, enhancements to the version used in Task Force XXI have already been implemented. For Task Force XXI, the network was limited because lower level echelons (brigade and below) required gateways to communicate with upper echelons (division and above). In effect, the Army used a segmented/two-tier architecture, lower TI, and an upper WIN-T (then known as Mobile Subscriber Equipment) connected by a somewhat inflexible routing device. As a result, this system was fragile and caused transmission delays. The nonroutable gateways are expected to be replaced with routable interface devices in the First Digitized Division. Ultimately, the FDD will have one integrated WIN where user applications will be optimized. In effect, information can go directly from any ABCS/BFA user (host) to any other ABCS/BFA user.

Integrated Systems Control

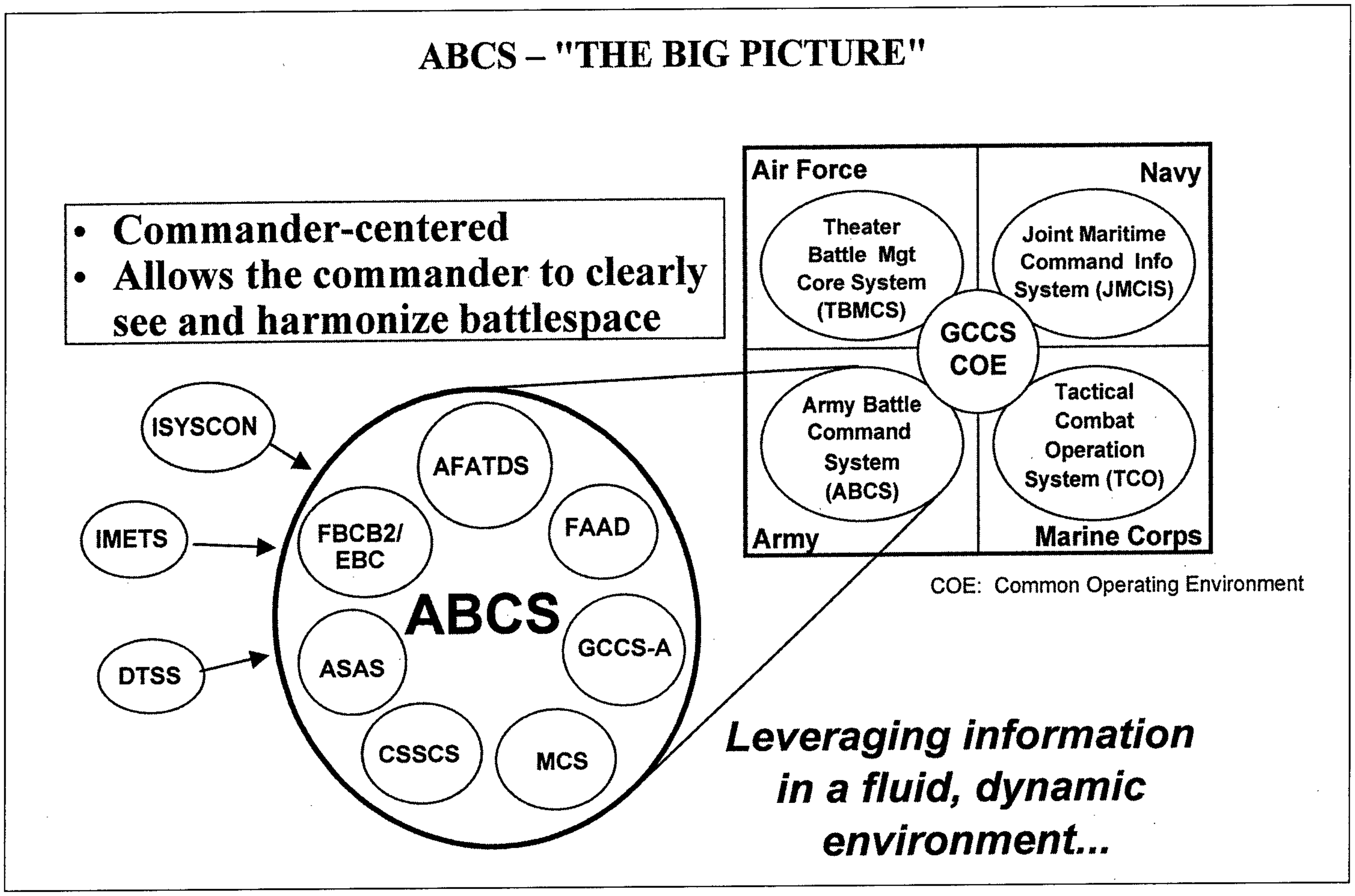
Key to the success of the FDD is the availability of network management capabilities, including tools to manage associated command, control and communications systems. One of these tools, Integrated System Control (ISYSCON), will provide an Army-wide family of tools to meet FDD network management requirements. Specifically, ISYSCON will be used in planning, initializing, monitoring, configuring, and troubleshooting requirements for command, control and communications systems.

Operational Facilities

For several years, the Army has been working on development of the Standardized Integrated Command Posts System (SICPS). Available in four variants (the High Mobility Multipurpose Wheeled Vehicle soft top and rigid wall shelters, the M577, and the 5-ton truck), the SICPS provides a

ABCS SUBSYSTEMS

ABCS SUBSYSTEM	FUNCTION
Maneuver Control System (MCS)	Plans, coordinates, and controls current operations, and develops and distributes plans, orders, and estimates in support of future operations.
All Source Analysis System (ASAS)	Develops and provides the picture of enemy situation to commanders at all echelons. Accesses information from national, theater, and tactical sources.
Advanced Field Artillery Tactical Data System (AFATDS)	Provides automated support for the planning, coordination, control, and execution of close support, and deep fires from Army and Joint (Naval gunfire, close air support) assets.
Forward Area Air Defense (FAAD) Command, Control and Intelligence	Integrates air defense fire units, sensors, and command and control centers into system for defeating low-altitude threat and enables commanders to plan, coordinate, direct, and control the counter air fight.
Combat Service Support Control System (CSSCS)	An automated system for logistical, medical, financial and personnel support. Provides critical combat service support information to assist decisionmaking and battle planning process.
Global Command and Control System – Army (GCCS-A)	Provides access to the Global Command and Control System. Disseminates common operational picture data between the Army and other Services.
Integrated System Control (ISYSCON)	Performs network planning and management of the communications architecture.
Integrated Meteorological System (IMETS)	Provides weather information based on inputs from Air Weather Service and meteorological sensors.
Digital Topographic Support System (DTSS)	Produces topogaphic products, to include multiple full-color maps of the battlefield and custom maps in digital format.
Force XXI Battle Command Brigade and Below (FBCB2)/Embedded Battle Command (EBC)	Develops and provides situational awareness and relevant battle command information of friendly troops at brigade and lower echelons. Disseminates situational awareness information to brigade and lower echelons.



standard environment for placement of command and control systems and radios in a vehicle.

The Project Manager for Forward Area Air Defense is leading an initiative to assist in development of rapid, reconfigurable Tactical Operations Centers for the FDD. A contract for this facility, using emerging and existing military, commercial, and nondevelopmental item technologies, will be awarded during the first quarter of FY99 for delivery 6 months after contract award.

Conclusion

Fielding of the FDD will place the Army on the threshold of tomorrow, providing our nation with unprecedented capabilities for handling all types of threats, from major wars to civil unrest. At the heart of the FDD is the Army Battle Command System, the keystone for collecting, analyzing, distributing and monitoring information on the future digitized battlefield. Located in units from joint forces headquarters down through the foxhole, ABCS will signal a "new way of doing business." Major activities are expanding our focus to support the joint and combined warfighters. Our experience with the Air Force in the fielding of ABCS at the battlefield coordination detachments is the first of many such activities. Other activities include the support of joint exercises, the definition of joint requirements, and the establishment of interoperability standards with our NATO allies.

The FDD is the culmination of a major undertaking by the PEO-C3S community and the initial fielding of the entire ABCS. It is also a starting point as we move forward to the First Digitized Corps in 2004 and the push forward into the joint and combined arenas that provide the Army with the means to support the revolution in military affairs.

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It's More Than Technology . . .

IMPLEMENTING FORCE XXI

Richard J. Hyde and
Joe R. Gonzalez

Introduction

Of the many challenges associated with Force XXI, the fielding and implementation of the resulting Army XXI is probably the greatest. Unlike previous modernization efforts, Force XXI is a total makeover, affecting virtually every warfighting platform and command and control system in a unit. While much attention has been given to the attributes of digitization, such as shared situational awareness and improved control of the operational tempo, relatively little attention has been paid to the process of transitioning a unit from "analog" to "digital."

This complex transition process is being executed with the 4th Infantry Division (4ID) at Fort Hood, TX, by the Digital Force Coordination Cell (DFCC), which has taken a DTLOMS-based approach to facilitating this mammoth modernization effort. (DTLOMS is an Army acronym that lists all major force modernization areas required for warfighting integration: doctrine, training, leader development, organizations, materiel, and the soldier.) While the DFCC and its predecessor, the Exfor Coordination Cell, have accomplished much, the lessons learned are of real value as Force XXI migrates from the 4ID at Fort Hood to the rest of the Army. This transition must ensure a successful modernization, while preserving the operational readiness of the units involved.

DFCC Background

In 1995, then Army Chief of Staff GEN Gordon R. Sullivan tasked the U.S. Army Training and Doctrine Command (TRADOC) with the lead in redesigning the operational forces as part of the Force XXI Campaign Plan. To facilitate that effort, GEN William W. Hartzog, Commander, TRADOC, established a staff agency at Fort Hood, the Exfor Coordination Cell (ECC), to transform the then 2nd Armored Division, which was designated the Experimental Force (Exfor), into a Force XXI organization. In 1997, ECC's name changed to the Digital Force Coordination Cell after the Task Force XXI Advanced Warfighting Experiment (AWE) and in recognition of the move from experimentation to fielding digitization. COL Joe Leigh currently heads the DFCC and is backed by a staff of 10 officers. Supporting him are two officers and seven government civilians who comprise the Army Materiel Command's Materiel Development Cell. In addition, numerous other military officers, government civilians, and contractors provide assistance. Regardless of the number of outside agencies involved in the DFCC, the officers assigned to TRADOC remain at its core. As such, they are well integrated into the Army's schoolhouse and operational units.

Unlike previous modernization efforts, Force XXI is a total makeover, affecting virtually every warfighting platform and command and control system in a unit.

The DFCC mission is to perform the full range of DTLOMS coordination necessary to digitize the 4ID by FY00, the 1st Cavalry Division by FY03, and the III Corps by FY04. In addition, the DFCC serves as the Army's single point of entry between the Exfor and the rest of the Army. To facilitate this coordination, the DFCC is organized according to DTLOMS, which permits institutional focus on each vital area.

DTLOMS-Based Effort

Central to the methodology for implementing Force XXI is ensuring all the Army DTLOMS are kept in balance. A brief discussion of each of the major force modernization areas (DTLOMS) required for warfighting integration follows.

Doctrine. Manifested in field manuals, texts and other publications, doctrine is used to guide how the Army fights. In the Force XXI effort, TRADOC is continuously evolving TRADOC PAM 525-5, *Force XXI Operations*, the capstone manual for Force XXI. At division level and below, unit techniques and procedures iterate quickly, often getting far in front of the current doctrine and tactics, techniques, and procedures

(TTPs). MG Robert Goff, the TRADOC Deputy Chief of Staff for Training, has established the Doctrine/Training Development Instructional Activity to coordinate and improve the doctrine and training instruction provided by the various proponent schools. Training and doctrine developers will be stationed at Fort Hood to synchronize this effort.

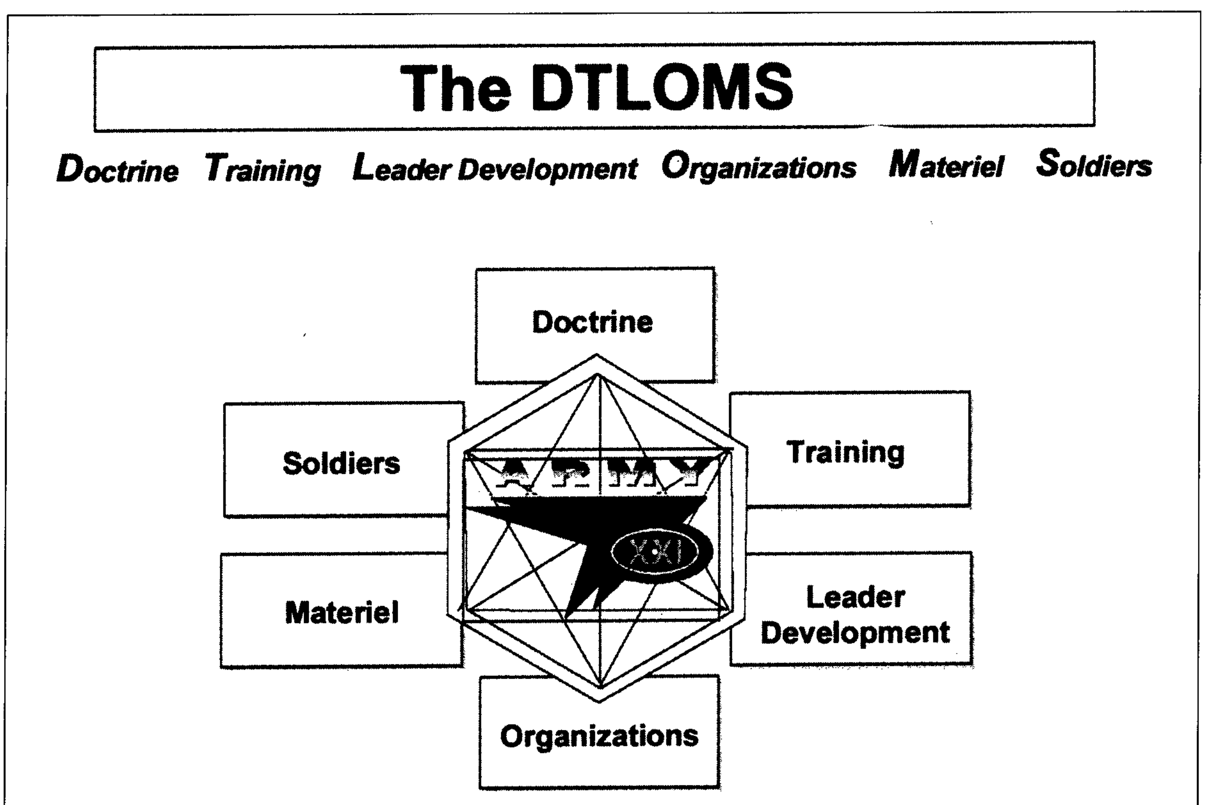
Training. This encompasses products, events and simulations used to train soldiers. Simulations such as Janus, Simulation Network and Corps Battle Simulation (CBS) have become critical training tools to prepare for digital exercises and experiments. These tools, however, are not current and provide varying degrees of limited functionality in interacting with and supplementing current digital training. To implement Force XXI, the latest products such as the Close Combat Tactical Trainer (CCTT), Warfighter Simulation 2000 (WARSIM) and embedded training must develop and mature quickly to meet near-term and future training requirements. Another challenge is the retention of digital skills. New systems are needed to allow soldiers to use their battlefield automation systems in garrison, thus increasing their training opportunities and minimizing digital skill degradation. The Program Executive Office for Command, Control and Communications Systems (PEO-C3S) and the TRADOC Program Integration Office for the Army Battle Command System (ABCS) are already moving in this direction by specifying and developing a common interface for all the ABCS subsystems in the next 2 years.

Leader Development. Leader development is the sum of the schools, courses, training, and personal professional development required for leaders to properly leverage doctrine with their soldiers, organizations and equipment. Digital leader training is essential to training tomorrow's Army leadership. Leaders must have confidence in the equipment and understand the technology to make proper decisions. Digital leader reaction courses are being developed at Fort Leavenworth, KS. These courses will need to be integrated into all the Army schools and U.S. Army Forces Command posts.

Army Experiment 5 (AE5) will conduct experiments designed to enhance leader decisionmaking skills in a digital environment. AE5 objectives are to support the development of a digitized leader reaction course, identify methods to optimize the management of battle command information and situational awareness, examine the implementation of emerging training strategies, and leverage new emerging training systems (WARSIM, CCTT, and Aviation Combined Arms Tactical Trainer). AE5 has several initiatives ongoing within the 4ID.

Organizations. These are the new and revised organizations necessitated due to changes in the other DTLOMs. Organizations are designed to maximize the net effect of improved materiel, soldiers, training, leader capabilities, and doctrine. Due to the insights gained from the November 1997 Division AWE and numerous other simulations and analyses, the Army announced on June 9, 1998, the move to the Conservative Heavy Division Design as part of realizing and migrating to Army XXI. The new leaner Army division will be more flexible, deployable and ready without sacrificing force effectiveness.

Materiel. This is the new equipment that is developed and fielded. The AWE process has ensured that much of the Army's latest digital equipment will be fielded with the "muddy thumbprint" of the operational user in multiple iterations of development and use. This spiral development has been a great boon to the Army. However, due to the rapid turnaround, improved functionality, and new capabilities, some fieldings have resulted in units receiving equipment without updated or appropriate doctrine, training and maintenance



issues fully resolved. This is the dilemma of the digital age: How much risk should we assume in fielding go-to-war equipment that may have a few digital bugs? There is a difference between "good enough" and "immature," and in this case, we must ensure that immature systems are not allowed to degrade our warfighting requirements. Industry routinely sells 90-percent solutions and then offers free or nearly free patches, but such a scheme has not been embraced in the military and may not be reliable enough for Army requirements. We must field operationally functional and sound solutions while ensuring upgrades meet the same criteria.

One way to mitigate these challenges is a close relationship between the fielding TRADOC system manager (TSM), the program manager (PM), and the operational unit. The experimentation of Force XXI Battle Command Brigade and Below has been a case study into how close coordination can overcome the inevitable flaws in a new system. Scheduled reviews and in-progress/in-process reviews as well as the on-post presence of the TSM and PM have resulted in a working relationship among all parties and a quick resolution of system problems.

Soldiers. This includes the individual training, recruitment and retention of soldiers. Accessing and retaining quality soldiers will be an increasing challenge in the Force XXI Army. This is being addressed by providing a robust training capability at Fort Hood in the Central Technical Support Facility (CTSF) and the soon-to-be-built Force XXI Soldier Development Center. These facilities will provide new equipment and sustainment training to Force XXI soldiers. In addition, the Office of the Deputy Chief of Staff for Personnel will change the mixture of Military Occupational Specialties to support the Force XXI unit.

Force XXI Database And Synchronization Calendar

To ensure that equipment arrives on time and in acceptable condition for soldiers to begin training, the DFCC has developed two sophisticated products that track progress in this area. The first is the Force XXI database, which is a Microsoft Access database that tracks the condition of various materiel initiatives (weapons, command and control systems, and platforms) that are being fielded to the 4ID. DFCC action officers assess each system with various measuring criteria and rate those criteria red, green, or amber. For instance, if a notional M1AX Platform lacks the TTPs and training support packages to adequately train the system, it would be "red" for "doctrine."

A second product that has been instrumental in this process has been the DFCC synchronization calendar. This calendar contains the training, exercise, fielding, and testing schedules for all the systems involved in meeting the First Digital Division timeline of FY00. It is updated at quarterly synchronization sessions held at Fort Hood. It provides an easy way to visualize the complex scheduling issues associated with training and fielding the myriad of systems involved in the Force XXI process. Just as important, the calendar is "ground truth" for the Army and allows all Army elements a reliable way to ensure their systems are accurately represented in the process.

Both these products are disseminated via the World Wide Web. Although some of the information is password protected, the Force XXI Intranet website allows military users to gain current information on the progress of fielding the First Digitized Division. The website is at **http://199.221.105.20/digitize/**.

Experimentation

Integral to Force XXI is the experimentation that preceded the fielding decisions. The 1997 Task Force and Division AWEs provided a vehicle to mature new technologies to the point where the 4ID could use and learn from them in a training exercise. Task Force XXI provided insights into fighting a networked brigade combat team (BCT). The 1st BCT, 4ID, trained for 6 months, which culminated with a rotation to the National Training Center in March 1997. The successful rotation showed the value of digitally enhanced situation awareness and command and control.

In December 1997, the 4ID executed the Division AWE. This CBS-driven Command Post Exercise involved tactical operations centers (TOCs) from battalion to corps, and provided additional insights regarding the value of digitization. Primarily, it showed that brigades and divisions can fight a much larger battlespace. It also proved the value of such technologies as whiteboard video teleconferencing and groupware (e.g., e-mail, web pages) to refine and develop operations orders. The main challenge in this area is to make these TOCs mobile and survivable on the battlefield.

TRADOC is in the process of designing experiments for the light, joint and Army After Next environments. At Fort Hood, the experimentation effort will be transformed into a series of capstone exercises for the divisions and corps to refine and mature the DTLOMS changes made in the Force XXI transition.

Conclusion

The future success of the Army depends on leveraging information dominance. We have started with the Force XXI process. How this process is done is as important as what technology is brought to the battlefield because both will define how well we maintain and sustain information dominance in the future. Army Chief of Staff GEN Dennis J. Reimer recently said, "The Army After Next that Force XXI will lead us to is not just about technology; that may be the easiest part. The hardest part is to develop the leaders necessary to lead that Army After Next, to develop the doctrine, the training system, and to keep all these developments in synch." The organizations and processes established at Fort Hood (the DFCC, CTSF, and PM-TSM-contractor partnerships, as well as those agencies supporting this process around the Army) are off to a good start toward making GEN Reimer's vision a reality. There are many lessons to be learned, but as long as the DTLOMS are kept in balance, the promise of Force XXI and Army After Next can be realized.

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JOINT TACTICAL RADIO SYSTEM PROGRAM

COL Wells Barlow and
LTC Edward Poore

Introduction

The Joint Tactical Radio System (JTRS) family of radios is an essential element of future military communications. JTRS will allow military commanders to command and control their forces by effectively communicating voice, video, and data during all aspects of military operations. The JTRS will provide a common technology base to enable the cost-effective procurement and life cycle support of tailorable, software-programmable, multiband, multimode radios supporting warfighters at all levels including those with high-data transfer rate requirements. The JTRS is essential to achieving the Joint Vision 2010 goal of information dominance, and will provide operational forces with an upgraded communications capability and ensure interoperability among joint and coalition forces.

Background

The Army's Future Data Radio Mission Needs Statement (MNS) was used to develop the Joint Tactical Radio (JTR) MNS, which was approved by the Joint Requirements Oversight Council (JROC) on Aug. 21, 1997. Subsequently, on Dec. 11, 1997, the Under Secretary of Defense for Acquisition and Technology designated the Army as the executive agent for the JTRS research, development, test, and evaluation effort, and approved an initial budget of $15 million in FY98 and $19.5 million in FY99.

On March 23, 1998, the JROC validated the JTRS Joint Operation Requirements Document (JORD) key performance parameters and delegated JORD approval authority to the Army. On April 10, 1998, the Under Secretary of Defense for Acquisition and Technology concurred with the JTRS Overarching Integrated Product Team (OIPT) recommendation for an evolutionary acquisition and spiral development strategy and a nontraditional

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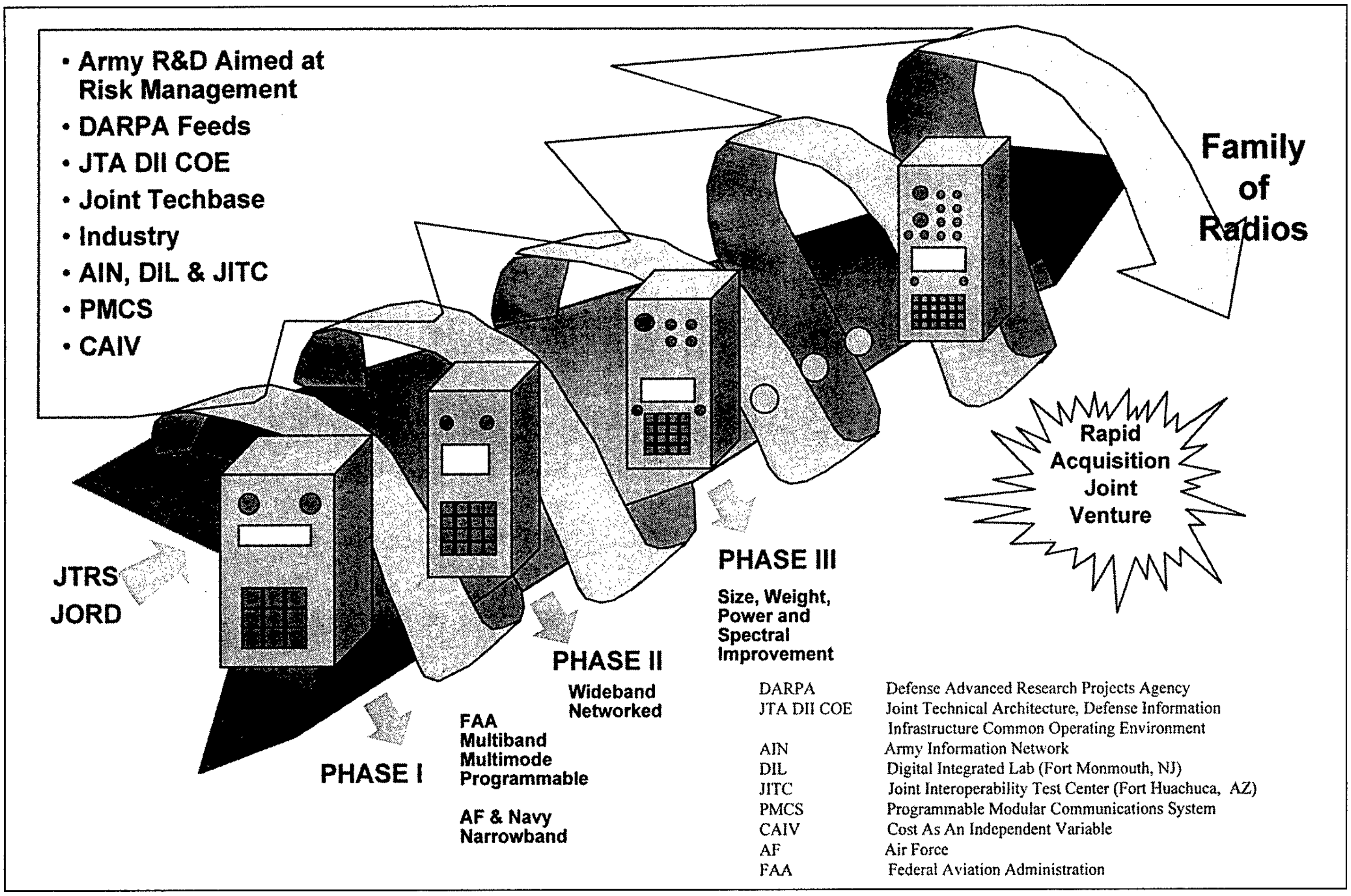


Figure 1.
Joint Tactical Radio spiral acquisition approach.

oversight and review process.

Program initiation and startup of the JTRS Joint Program Office (JPO) will occur when Congress approves the Department of Defense (DOD) New Start Program request. This JPO will oversee the JTRS acquisition process, and will be responsible for the development, maintenance, and evolution of the JTRS architecture.

Program Goals

DOD has established goals for the JPO as part of its long-term strategy for a communications infrastructure. Some of these goals are:

- Technically adequate and timely response to Service radio communications needs;
- Reduction in the cost of development, acquisition, and ownership of radio communications;
- Continued industry interest in Defense communications technology evolution; and
- Industry-wide opportunity for production and enhancement of the various "form factors" of the JTRS.

Strategy

The JTRS is intended to be based on a "business case" development process. The significant opportunity for multi-Service total life cycle cost reduction is a key factor in this equation. The development focus will be driven by Service needs, while being constrained by technical and budgetary reality. Part of the fiscal and technical reality of the JTRS Program is the use of a spiral development process to incrementally provide a family of JTRS radio capabilities (Figure 1). Each subsequent increment will expand upon preceding JTRS capabilities through software reprogramming and/or the addition of new modules (hardware and/or software). The JPO will bring these capabilities to the point where competitive commercial off-the-shelf acquisitions are possible.

The primary focus of the JPO will be to maximize software reuse and portability, provide cost-effective hardware commonality, minimize operations and support costs, and improve joint interoperability. To reduce the overall DOD costs over the life cycle of all future radio systems and reduce interoperability problems among the Services, each radio system will adhere to a JTRS architecture that is developed as the first step of this program. This approach requires the extensive use of acquisition reform and joint cooperation, and recognizes that for the program to be successful, the requirements and test communities must also experience similar paradigm changes.

Management of JTRS product acquisitions will be the direct responsibility of Service project management offices (PMOs). These offices will perform the actual acquisition and contract management for the production, fielding, and initial operational support of the various JTRS physical configurations. System integration and the functional activity associated with specific host platforms remains the responsibility of the prime system managers. The JTRS JPO will assist the designated Service PMOs in the transition from the JTRS technical risk reduction phase through a single milestone decision for the production of a particular JTRS radio family.

This family of radios will support the three general domains identified in the JORD: airborne; maritime/fixed station; and ground forces. The domains identified in the JORD are similar to the five military and civil domains identified by the Programmable Modular Communications System (PMCS) Guidance Document: airborne, ground mobile, fixed station, maritime, and portable-manpack (Figure 2). Key elements of this new way of acquiring military radio communications are summarized below.

JTRS Open System Architecture. Developing and maintaining the JTRS open system architecture will include a number of activities. Development of the initial architecture will be based on the detailed analysis of current requirements, waveforms, and available technology with a view toward future expandability that will ensure backward compatability. The JTRS architecture will be developed via close partnering between the Services and industry. The JPO will ensure that extensions of the architecture necessary for capability growth are technically consistent with the baseline architecture and will meet software portability criteria. The JPO will provide architectural guidance for all Service-managed contractual efforts to develop and rehost waveforms. The JPO will sponsor development of common software and hardware interfaces and will maintain configuration control of the JTRS architecture (Figure 3).

JTRS Roadmap and Migration Plan. One of the JPO's most important responsibilities is developing and monitoring the JTRS roadmap and migration plan. The plan will involve the integration of all Service operational needs with the JTRS schedule. This activity will support designation of the lead Service for specific procurement actions based on the relevant business case. The intent of this plan is to direct the focus of the JTRS Program in a way that will result in the lowest unit price for the highest density of a specific physical configuration for radios. The roadmap will ensure a single DOD acquisition approach for all radio procurements.

Program Oversight and Review. The JPO will be the single point of contact within DOD for the JTRS Program. The JPO will recommend Service leads for the procurement of JTRS products—based on the roadmap and migration plan—that will maximize commonality and provide efficient delivery of capability. The program office will provide assistance to the Services for any JTRS-related acquisition milestone decisions, and will recommend appropriate acquisition strategies to the Office of the Secretary of Defense (OSD) for future Service procurements. An OIPT chartered by the Assistant Secretary of Defense for Command, Control, Communications and Intelligence will

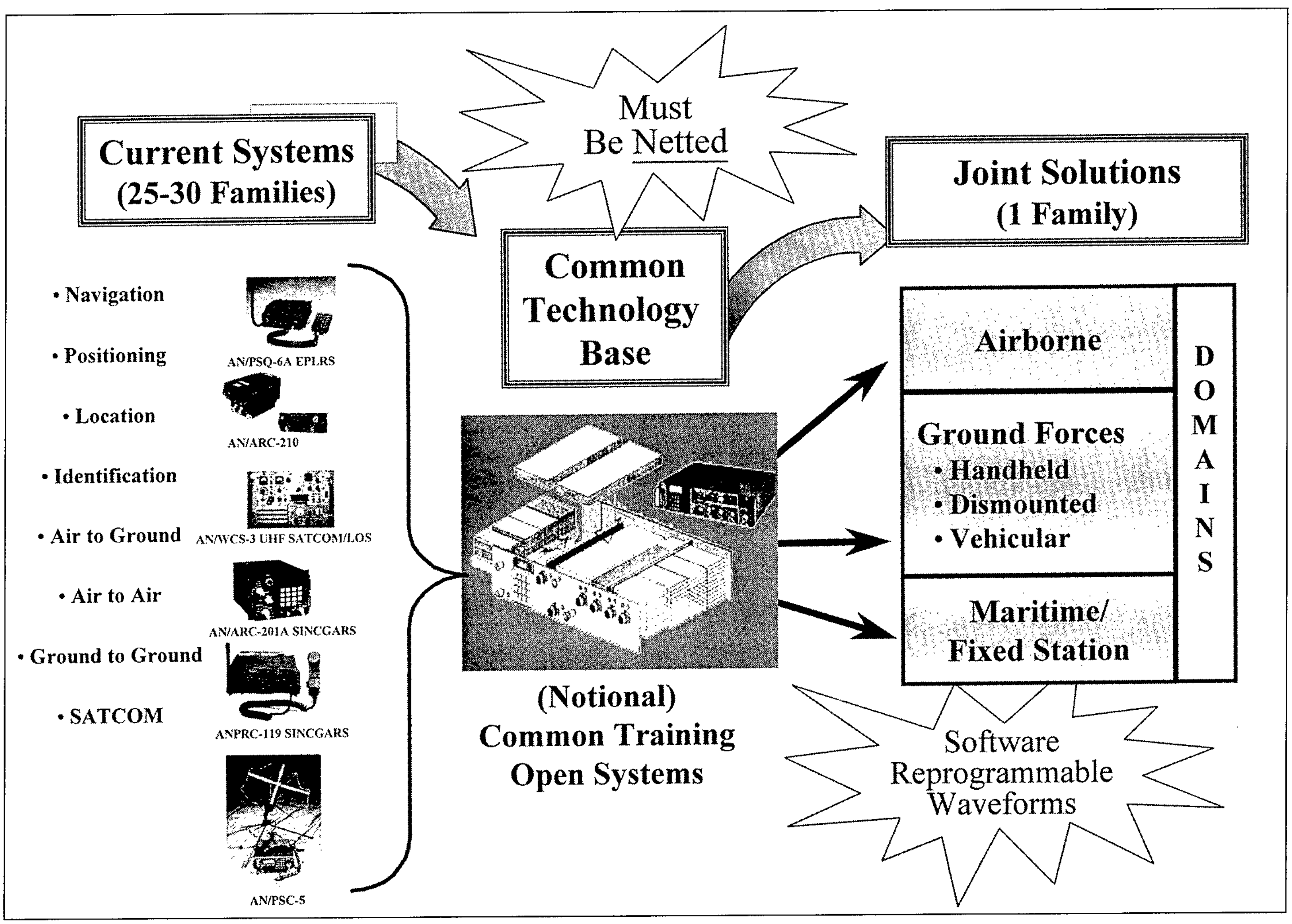
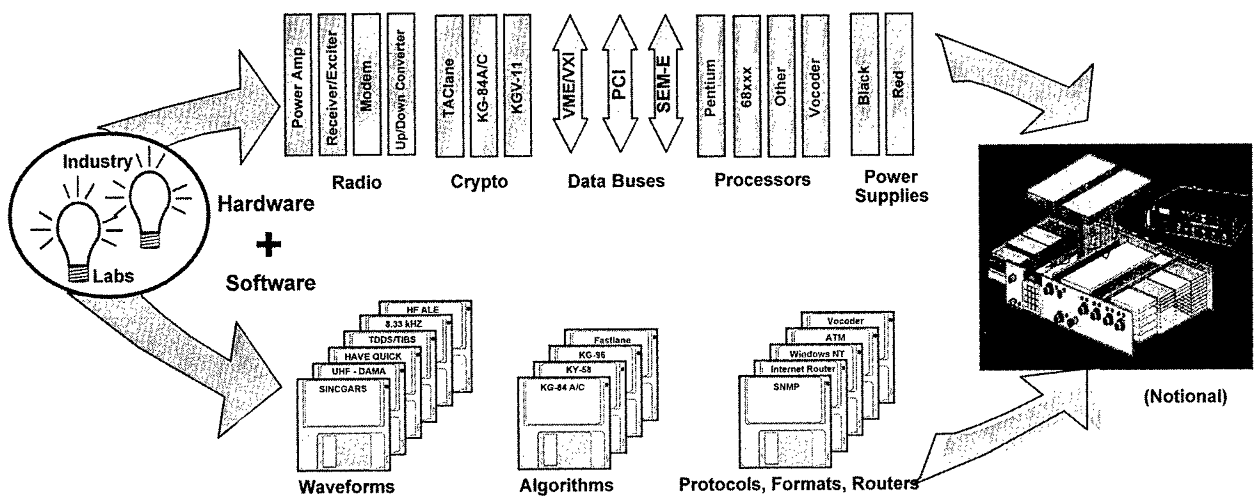


Figure 2.
Joint Tactical Radio System family of radios.



- **Consistent with PMCS Integrated Product Team Guidance Document**
- **Implements Open Systems Architecture for all DOD Radios**
- **Eliminates Stovepipe Radio Buys and Enhances Interoperability**

Figure 3.
Joint Tactical Radio System architecture.

provide OSD oversight of the JTRS Program.

DOD Radio Acquisitions. The JPO will review all DOD radio acquisitions and monitor nonacquisition developments to ensure they are consistent with the DOD-wide JTRS architecture and migration plan. PMOs will provide Requests for Proposals (RFPs) for future radio development or procurement efforts to the JPO no later than 30 days prior to release. The JPO will review the RFPs for consistency with the JTRS architecture and standards. The assessment of pending Service acquisitions will determine the degree of JTRS compliance and the need to procure noncompliant radios due to extraordinary circumstances. Advanced technology developments will be monitored to ensure that radio technology development remains focused on the assessment of technologies that will enhance or support the JTRS architecture.

Research, Development, Test and Evaluation (RDT&E) Funding. The JPO will manage the joint Service RDT&E funding to ensure that the resources fully support the development of the JTRS architecture in a manner that is most responsive to Service/mission needs. In addition, the JPO will monitor new technology in industry, academia, and government research and development labs, as well as user requirements. The JPO will leverage technical base R&D efforts or redirect program R&D resources to bridge any gaps between emerging requirements and available technology.

Domain Management Functions. JTRS domain management functions involve monitoring the development of the JTRS products to ensure the number of physical configurations and domain-unique functionalities are minimized and that common functionality and software reuse are maximized. The JPO will also ensure that life cycle support concepts, techniques, and resources are efficiently shared between and within domain areas.

User Requirements. The JPO will review all new user requirements to provide candid feedback to the requirements community on the ability of the acquisition community to meet emerging needs. The JPO will also work with the user and acquisition communities to "bundle" operational requirements in achievable, responsive delivery increments.

Conclusion

The strategy outlined for the JTRS is designed to reduce the acquisition and ownership costs of radio communications systems while providing upgraded voice, video and data communications capabilities. These capabilities will enable U.S. forces to more effectively operate with their joint, combined and coalition partners.

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ARMY ENTERPRISE XXI

BG James D. Bryan,
COL John C. Deal, and
LTC John A. Hamilton Jr.

Introduction

Army Enterprise XXI is designed to provide the Army with a C4/IT (Command, Control, Communications, Computers/ Information Technology) blueprint for information superiority. Information superiority is the capability to collect, process and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same [*Joint Vision 2010*, Page 16]. *Army Vision 2010* outlines the Army's contributions to *Joint Vision 2010* and specifies information dominance as fundamental to the Army's execution of force projection, force protection, shaping the battlespace, decisive operations, and force sustainment [*Army Vision 2010*, Page 10]. Information dominance is pervasive information superiority.

Information superiority is the organizing principle for both Joint Vision 2010 and Army Vision 2010. Therefore, the information network is the integrating mechanism for the joint forces as well as for the Army in the field. This requires the creation of a secure, seamless, global network. The vision of Army Enterprise XXI is to build a secure, knowledge-based world-class network for our world-class soldiers that will allow them access to knowledge capital, thus enabling a knowledge-centric force. An important corollary is that if the division and corps rear boundary is the sustaining base and we are digitizing the battlefield, then we must also digitize the sustaining base.

Army Enterprise Strategy

The emphasis on information superiority in both Joint Vision 2010 and Army Vision 2010 led the Office of the Director of Information Systems for Command, Control, Communications and Computers (ODISC4) to update the 1993 Army Enterprise Strategy. The Army Enterprise Strategy was the Army's vision of the Joint Staff's C4I for the Warrior. This was quickly followed in 1994 with publication of the Army Enterprise Implementation Plan, which contained nine tasks to implement "The Vision" as part of the original Army Enterprise Strategy.

Other new initiatives influenced the development of Army Enterprise XXI. The Army established the Force XXI process, and Task Force XXI successfully demonstrated the value of digitization and enhanced information management during an advanced warfighting experiment in April 1997. The ongoing information technology explosion coupled with these dramatic events served as catalysts for a revolution in military affairs (RMA) and a revolution in business affairs (RBA) within the Army. The RBA reflects the institutional Army focus on efficiency, and the RMA reflects the operational Army focus on effectiveness. The RBA and the RMA will evolve together, and this convergence will result in one Army performing as one team.

The Army Enterprise Strategy and its 10 principles, along with the Army Enterprise Architecture, is still valid and provides an excellent point of departure. However, as the history outlined above indicates, new concepts, new doctrines, new technologies, and new ways of doing business are continuously evolving. As the number of advanced C4/IT initiatives increases within every functional area, an overarching framework is needed to conceptualize these seemingly disparate programs. Army Enterprise XXI builds on the Army Enterprise Strategy by:

- Presenting the "foxhole" and the "sustaining base" as parts of the same architecture;
- Providing an integrated C4/IT view of the RMA and RBA;
- Providing conceptual C4/IT frameworks for today (platform-centric), Army XXI (2010, network-centric), and beyond the Army After Next (2025, knowledge-centric); and
- Providing implementation and investment guidance; i.e., an investment strategy.

Army Enterprise XXI examines and compares the concepts, capabilities, and areas of future C4/IT applications necessary to support Force XXI, Army XXI, and the Army After Next. It contains a vision built upon expected future operational concepts, capabilities, and enabling C4I/IT technologies that should be considered by the Army during the transition

The vision of Army Enterprise XXI is to build a secure, knowledge-based world-class network for our world-class soldiers that will allow them access to knowledge capital, thus enabling a knowledge-centric force.

Table 1.
The revolution in military affairs for the operational Army.

Army of Excellence FM 100-5 Characteristics	Army XXI TP 525-5 Characteristics	Army After Next Winter War Games Characteristics
• Hierarchical	• Flattened	• Heteroarchical
• Fixed Boundaries	• Fluid Boundaries	• Virtual Boundaries
• Object-Focused	• Structure-Focused	• Pattern-Focused
• Centralized	• Disintermediation	• Decentralized
• Mechanical Model	• Networked Model	• Biological Model
Technologies	Technologies	Technologies
• Subscriber Focus	• Network Focus	• Content/Context Focus
• Stove-piped Sys.	• Hybrid System of Sys.	• Transparent Arch.
• Terrestrial Comm.	• Airborne Comm.	• Space-based Comm.
• Data Accumulation	• Focused Data	• Fused Data
PLATFORM-CENTRIC CURRENT FORCE	NETWORK-CENTRIC PROGRAMMED FORCE	KNOWLEDGE-CENTRIC POTENTIAL FORCE

period. It provides broad direction for Army C4/IT investment strategies and related resource documents to leverage evolving information technology to satisfy future requirements.

From Army Of Excellence To Army After Next

During the first two decades of the 21st century, the Army will be moving toward knowledge-based land warfare. To achieve this capability, the Army intends to field its first digitized division in the year 2000 and the first digitized corps by 2004. Army modernization goals include a fully networked, digitized Army. These efforts, coupled with budget constraints, will leave the total Army team in an evolving state. This mixture of modernized legacy forces and infrastructures will create C4/IT interoperability challenges for the Army well into the 21st century.

As the transition from a forward presence of deployed forces to global power projection from CONUS and overseas bases progresses during the Army After Next timeframe, many of the functional differences between deployed forces and the power projection base will become transparent. Many critical functions that were once performed within the battlespace (e.g., intelligence, logistics) will be located at the power projection bases. In effect, the battlespace of the Army After Next will encompass all of the widely dispersed components of intelligence, firepower, maneuver, logistics, medical, and command. The full effect of modern precision firepower, maneuver capabilities, and split-based operations resident on the 21st century battlefield will not be realized without investing heavily in the information infrastructure that bind these components together.

The Army Enterprise XXI RMA Vision

The transition from platform-centric to the knowledge-centric concept will enable the Army to capitalize on the mental agility of Army XXI (2010) and combine it with the speed and physical agility required for the Army After Next (2025) environment. This progression is shown in Table 1. While the platform-centric concept was based on rigid, hierarchical command and control criteria, the knowledge-centric concept will be based on the interdependent triad of knowledge (managing interactions and exchanges), coherence (the links that enable interactions), and the warrior (the well-trained, highly motivated soldier).

The emerging network-centric concept in the 2010 timeframe will provide increased interoperability among different mission areas, services, and allies, but at the cost of increased complexity of network pathways, standards, and interfaces. The network-centric concept is an evolutionary approach to the RMA and the more revolutionary knowledge-centric concept for the Army After Next.

The fundamental precept of knowledge-centric warfare is that it provides access to information that is content and context focused. This content and context focus differentiates knowledge-centric warfare from network-centric warfare. The knowledge-centric concept requires an enterprise network that ensures seamless interoperability and greatly simplifies knowledge access for the end user. In this timeframe, software will become the central C4/IT investment component, allowing upgrades and reconfiguration by adding new versions of software instead of a total hardware replacement.

To achieve the network-centric concept by 2010, the C4/IT construct for Army XXI will be built around three conceptual interrelated information grids: the battle management grid, the sensor grid, and the engagement grid. The Warfighter Information Network will enable the network-centric concept for Army XXI to evolve to the knowledge-centric concept. The Army After Next C4/IT construct will consist of redundant layers of communication nets: terrestrial, low-to-high level unmanned aerial vehicle fields, and an umbrella of space-based systems. This enterprise network will have the flexibility and capability to dynamically reroute messages in a degraded communications environment. Layered communication nets and analytical nodes will match the rapid growth in precision firepower and rapid pace of maneuver forces on the 2025 battlefield.

Army Enterprise XXI RBA Implementation

To implement the vision, the Army will exploit commercial technology by employing new operational concepts and organizational structures. The benefits of commercial off-the-shelf products will be realized in significantly reduced IT research and development costs coupled with the rapid fielding of the latest IT tools and applications. The Army recognizes the critical role information plays in the success of Army XXI and the Army After Next. C4/IT provides the information content to enhance combat power and speed of command, giving our soldiers significant advantages. The RMA defines the operational challenges the Army faces. To ensure the Army meets these challenges, it will employ RBA processes that will enable the Army Enterprise XXI vision. The Army will acquire, through the marketplace or through military development, sensors, communications equipment, and applications that will capture, synthesize, and distribute information. Through the RBA, the Army will capitalize on new IT in the commercial market and industry best business practices.

Just as with the RMA, there are a number of emerging characteristics, concepts, and desired capabilities associated with the RBA as we evolve from the platform-centric era, through the network-centric period, to the knowledge-centric era (Table 2). The mechanism for achieving the RMA within the battlespace is digitization. The objective is to build an installation information infrastructure to enable revolutions in the way the Army conducts its institutional business. It is only through the judicious application of information technology coupled with business process reengineering that Defense reform initiatives, operational reachback, distance learning, prime vendor support, and electronic shopping malls along with a host of other C4/IT-dependent programs will be realized.

Conclusion

This Enterprise XXI vision and implementation plan will be central to the Army's development of an intelligent, flexible investments strategy for information superiority. Thus, Army Enterprise XXI provides the C4/IT ends, ways, and means for achieving the objectives of Army Vision 2010 and developing the Army After Next. This C4/IT implementation planning process will strengthen current and future Army military capabilities and help maintain the readiness of the Army as it evolves to the mentally and physically agile 21st century Army in the 2025 timeframe.

Table 2.
The revolution in business affairs of the institutional Army.

Army of Excellence FM 100-5 Characteristics	Army XXI TP 525-5 Characteristics	Army After Next Winter War Games Characteristics
• System-based acquisition	• Module-based acquisition	• Capabilities-based acquisition
• Mass Fielding	• Rapid Fielding	• Rapid Tailoring Fielding
• Inventory-based logistics model	• Information-based logistics model	• Knowledge-based logistics model
• On-site mass training	• Remote mass training	• Remote tailored training
Technologies	Technologies	Technologies
• Word processing/paper	• Web-based electronic commerce	• Intelligent software agents
• Scheduling programs	• Scheduling programs	• Automated transfer & tracking
• Stand-alone databases	• Distributed databases	• Embedded logistics
PLATFORM-CENTRIC CURRENT FORCE	NETWORK-CENTRIC PROGRAMMED FORCE	KNOWLEDGE-CENTRIC POTENTIAL FORCE

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TAKING DIGITIZATION TO OUR ALLIES

LTC Charles E. Milster,
LTC Michael C. Parish, and
MAJ Graham R. Le Fevre

Introduction

Faced with the challenge of maintaining and modernizing military forces to meet a variety of unpredictable worldwide threats, the United States expects to participate in multinational cooperative actions to meet future mission requirements. DOD Directive 4630.5 states that forces for joint and multinational operations must be supported through compatible, interoperable, and integrated command, control, communications, computer, and intelligence (C4I) systems that can support operations worldwide throughout the entire spectrum of conflict. As Army plans for digitizing the battlefield move forward, this requirement becomes more pressing.

The U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-5, *Force XXI Operations*, states as a goal that these operations be conducted under conditions where U.S. forces, supported by coalition partners, enjoy a qualitative technical, training, leadership and, most importantly, information advantage. Digitizing the battlefield, one of the objectives of the Army Enterprise Strategy, will lead toward the realization of this goal by providing an integrated digital information network to support warfighting systems and ensure command and control (C2) decision-cycle superiority.

Organizational Responsibilities

The Army Digitization Office (ADO) has overall responsibility for implementing and executing the international digitization strategy. ADO carries out this function within the structure of the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS) and in conjunction with the Office of the Deputy Under Secretary of the Army for International Affairs (ODUSA-IA); the Office of the Director of Information Systems for Command, Control, Communications and Computers (ODISC4); and the Program Executive Office for Command, Control and Communications Systems (PEO-C3S) (see Figure 1).

Purpose

The International Digitization Strategy (IDS) is designed to focus the international activities of the Army in support of the goals and objectives outlined in the Army Digitization Master Plan (ADMP). The IDS presents the overall strategy for international cooperation in the application of doctrine and technology to facilitate acquisition, exchange, and employment of digital information throughout the combined battlespace. The priorities and processes outlined in the IDS will enhance the

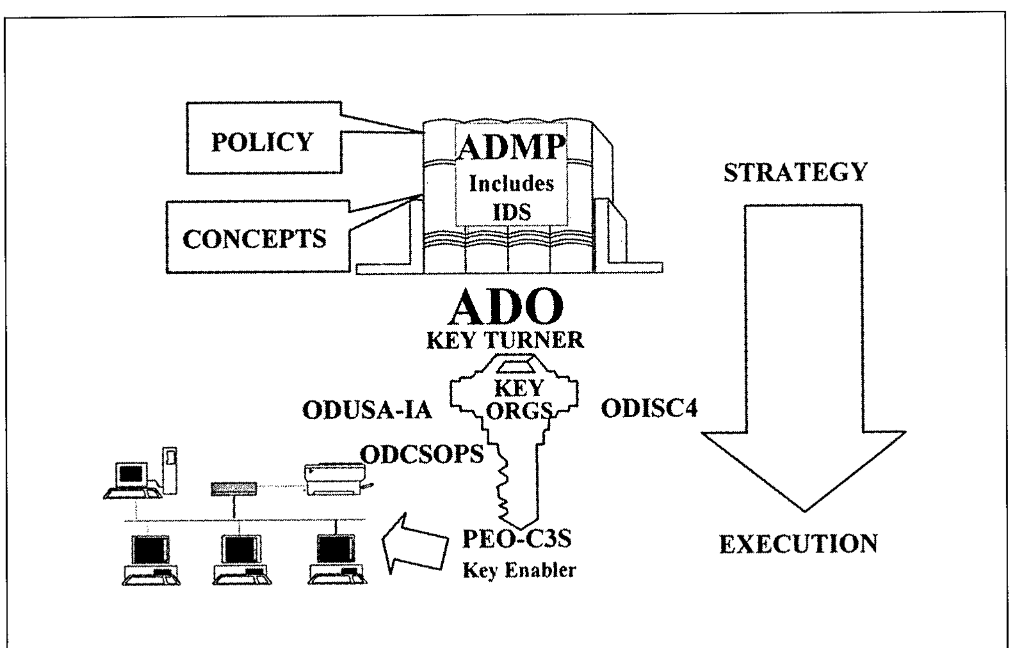

Figure 1.
Key U.S. Army organizations.

ability of the Army and its coalition partners to field inherently interoperable systems.

Concept

The concept for achieving multinational force interoperability is based on the following underlying precepts:

- Develop the doctrinal framework and concepts that provide the underpinnings for international digitization;
- Adopt commercial standards where appropriate to achieve open systems;
- Develop standards for interoperability where none currently exist;
- Use existing C4I forums to promote the integration of the Army's digitization initiatives;
- Leverage foreign advances in technology; and
- Pursue the application of emerging technologies to support coalition warfare and multinational operations.

The priorities and processes outlined in the International Digitization Strategy will enhance the ability of the Army and its coalition partners to field inherently interoperable systems.

Strategy

The IDS defines a systematic strategy and process to extend U.S. Army digitization efforts to the international arena. The process is based on establishing an understanding of U.S. digitization efforts, achieving interoperability with potential coalition partners, and pursuing short-, medium- and long-term cooperative opportunities. The process includes a number of elements designed to:

- Define the approach to achieve interoperability of C4I systems between key allies, to include broad agreements on policy and procedures concerning information exchange, architecture definition, and architecture development processes;
- Identify the key forums in which to coordinate national digitization positions and focus their efforts;
- Define and implement technical architectures applicable to all participating nations that will enable seamless information flow during coalition warfare;
- Develop cooperative multinational programs to share technology (e.g., components, systems, and standards) for the automated exchange of information;
- Evaluate developed interoperability capabilities operational/lab environments;
- Develop a C4I operational architecture that will satisfy operational requirements for interoperability with multinational forces;
- Ensure that prototype systems developed via current/planned international cooperative programs meet interoperability goals;
- Pursue the consolidation of related efforts through appropriate international legal frameworks;
- Invite allies to observe U.S. Army Advanced Technology Demonstrations (ATDs) and Army Warfighting Experiments (AWEs) and to extend warfighting experimentation concepts into the international community; and
- Use existing test and evaluation sites such as the Central Technical Support Facility, Digital Integrated Laboratory, and the Joint Interoperability Test Center to simulate and confirm interoperability.

Key International Forums

Army participation in key international forums is essential for coordination and cooperation with coalition partners. These forums provide a mechanism for harmonizing the operational, system, and technical architectures of the member armies. Participation in international forums also facilitates the leveraging of advanced and emerging technologies identified as candidates for meeting future Army requirements. The key groups with the greatest potential for contributing to the digitization effort are:

- North Atlantic Treaty Organization (NATO) Army Armaments Group (Land Group 1);
- Senior National Representative (Army) forums;
- Quadrilateral Armies Communications and Information Systems Interoperability Group; and
- American, British, Canadian and Australian Armies' Agreement.

The next task is to focus these groups on relevant digitization efforts. The ADO will work with the designated lead activity for each forum to ensure that the goals and objectives of the ADMP and IDS are represented and consistently presented.

The United States, the United Kingdom, France, and Germany agreed to establish a One Star International General Officer Steering Group to advance international cooperative work. BG William L. Bond, Director, ADO, directed the exploratory work for this group, and in April 1998 met with his French, German and British counterparts to energize the process of international cooperation on digitization. The four nations agreed to emphasize message exchange in the near term and to reinvigorate the Allied Tactical Command and Control Information System (ATCCIS) initiative to develop direct data exchange and a future gateway function. When this article was written, another meeting—with participation by general officers from other countries—was tentatively planned for September 1998 at Fort Hood, TX.

Major International Digitization Programs

International digitization programs promote multinational force compatibility consistent with the objectives of the strategy. Key digitization initiatives and technology opportunities have been identified and will receive the priority needed to ensure that applicable international agreements are established and implemented.

Data/Information Exchange Annexes (D/IEAs) to appropriate memorandums of agreement facilitate the exchange of information related to digitization between nations. This information is essential to identify potential collaborative efforts and technology leveraging opportunities. D/IEAs are conducted on a quid pro quo basis and have clearly defined objectives.

The IDS includes the following cooperative efforts that are currently in place or being planned:

- The Command and Control Systems Interoperability Program (C2SIP), which encompasses the international Supreme Headquarters Allied Powers Europe-sponsored ATCCIS initiative of 11 NATO nations, and the Multilateral Interoperability Program (MIP) with Germany, France, Italy, Canada, and the United Kingdom;
- The Combat Identification Program with Germany, France, and the United Kingdom; and
- The Theater Automated Command and Control System for extending digitization in the confined battlespace of the Korean Peninsula between U.S. Forces Korea and the Republic of Korea Army.

International programs allow the United States to leverage the research and development investments of multinational partners. Worldwide technology trends and specific C4I technology leveraging opportunities are identified and referenced in the IDS.

Demonstrations And Experiments

A key component of the IDS is the use of demonstrations and experiments to evaluate developed capabilities in an operational environment, determine requirements for interoperability, and make allied partners aware of U.S. Army digitization efforts.

Multinational partners are invited to observe Army ATDs, digitization experiments, and AWEs. The TRADOC Battle Laboratory Integration Technology and Concepts Directorate will coordinate the scope, nature, and duration of foreign observation. Further coalition participation will be pursued on a selective basis so as not to adversely impact any U.S. program.

For the longer term, a process of multinational demonstrations, exercises and warfighting experiments is being developed (see Figure 2). This process is intended to reflect the Army's digitization approach of "build a little, test a little." Each nation is expected to demonstrate its developing capability and where it fits into their own

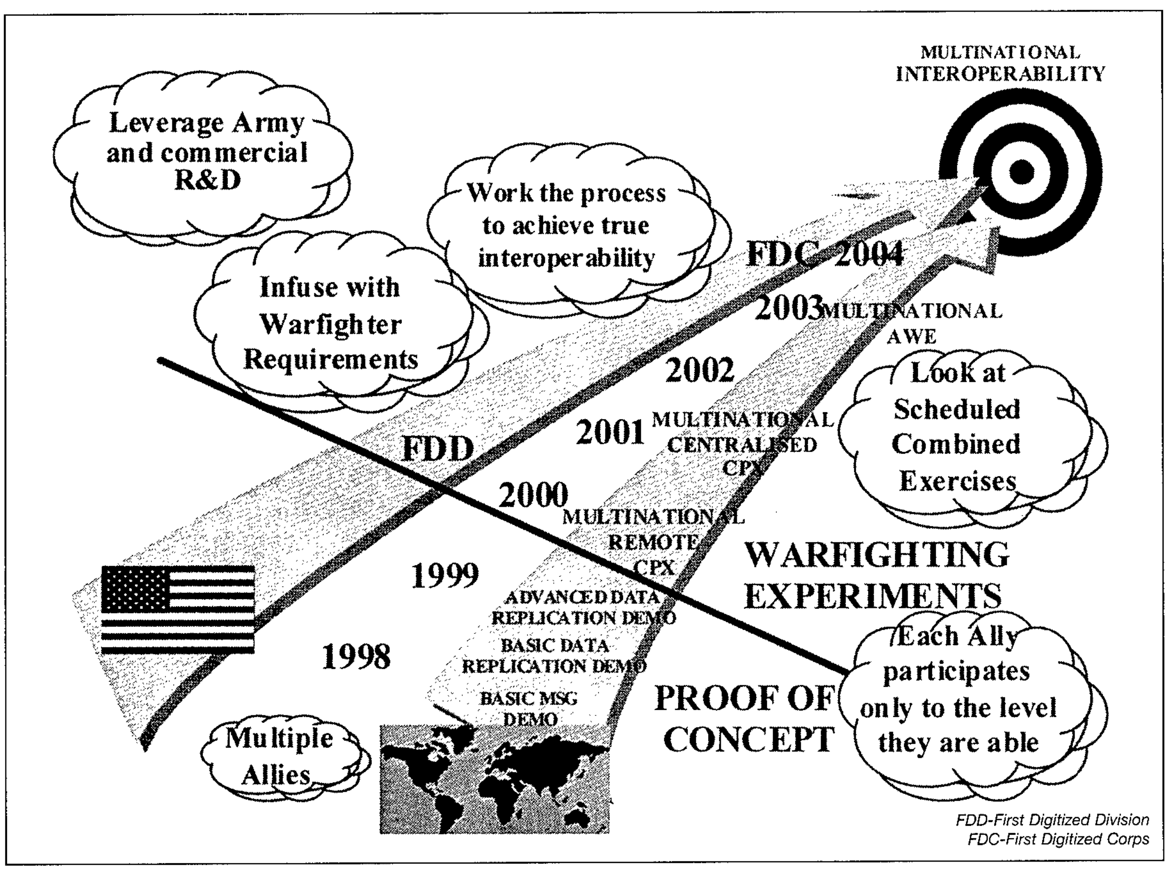

Figure 2.
The path toward international digitization.

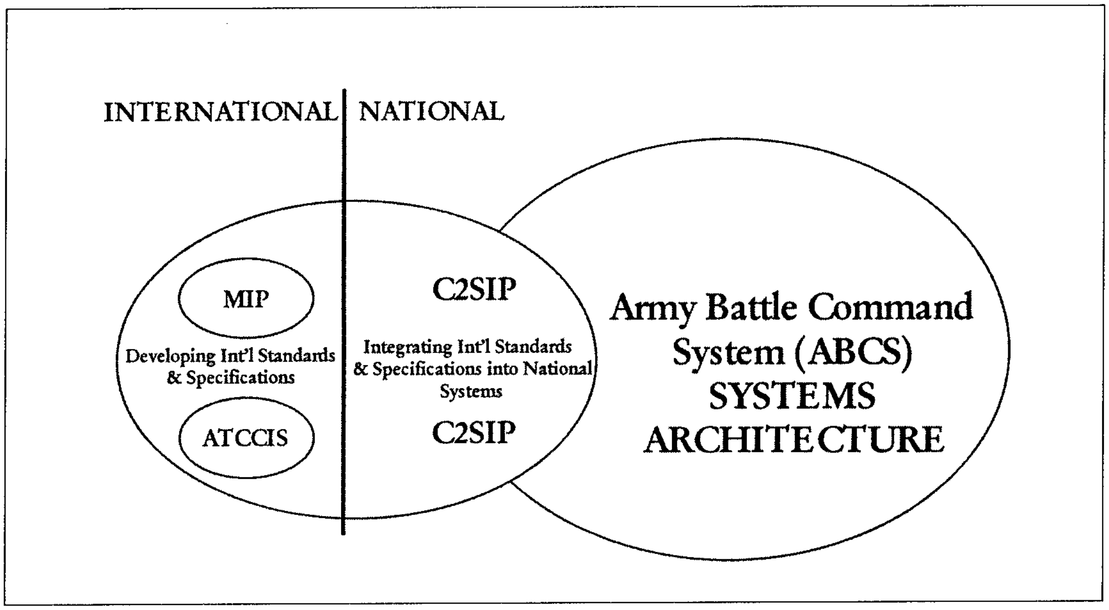

Figure 3.
Integrating the programs.

national digitization research and development schedules.

C2SIP

The C2SIP concept will provide the U.S. Army with a flexible capability to exchange data with multiple allies. This data exchange will occur between the primary Army C2 systems and would be achieved by other message exchange or by controlled replication of selected data. The C2SIP effort is integrated into the Army Battle Command System (ABCS) Systems Architecture (initially Maneuver Control System) and will refine elements of the Defense Information Infrastructure Common Operating Environment to include the international specifications. The capabilities will be developed and fielded in two phases. The first phase will be the fielding of a basic message capability (99/00), and the second phase will be the fielding of an advanced message and controlled selective data replication capability (01/02). Thus, by 2003 the Army will have a flexible capability to exchange data with allies who have only one of the two capabilities. Work is now underway with the other U.S. Services to identify requirements for passage of coalition land force data to their C2 systems and to involve them more closely with C2SIP.

C2SIP is the Army's approach to embedding the developing international specifications (MIP and ATCCIS) into its own C2 systems (see Figure 3). By focusing the work into a single program tied to a system, considerable resource savings are made. Moreover, it provides the Army with a single focus for international C2 system interoperability.

Conclusion

The intent of the IDS is to extend current digitization efforts to allies and potential coalition partners through information exchange, cooperative programs, commitment to common operational, system, and technical architectures and technology leveraging. International programs and initiatives involved in digitization will be assessed in accordance with TRADOC Pamphlet 525-5, the Army Enterprise Implementation Plan, and the ADMP to ensure that all aspects of doctrine, training, leader development, organization, materiel, the soldier, and technology issues are addressed. The strategy must continue to reflect changes in the global environment, science and technology, and political and economic forces. The excellent working relationship between the U.S. Army and its international counterparts has meant that significant progress has been made within recent months toward making international digitization a reality. This energy can now be focused on providing truly digitized coalition land forces for the new millennium.

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SIMULATION-BASED ACQUISITION: REAL-WORLD EXAMPLES

Sean P. Keller

Introduction

Currently, the Department of Defense (DOD) is engaged in an acquisition reform effort that focuses on the integration of technologies throughout the acquisition process to reduce cost, increase system performance, and reduce the time to field a system. This new way of doing business is termed "simulation-based acquisition" (SBA) because the key technologies that can make it a reality are modeling and simulation (M&S).

LTG Paul J. Kern, Military Deputy to the Assistant Secretary of the Army for Research, Development and Acquisition, subscribes to the notion that SBA is an integrated process that incorporates a seamless transfer of data and full interoperability of models and simulations across the requirements, acquisition, and training communities. For the Army, SBA is actually more than just acquisition.

The challenge in executing any new process is to find metrics by which to conduct comparative analyses to judge the viability of the new process. Likewise, with SBA, to date there has been no "pilot program" by which to judge the potential impact this may have on the acquisition process over the short and long term. There are, however, ongoing programs, albeit limited, that include some of the objectives. To that end, this article provides several examples from both industry and the government of how the principles of SBA have already impacted high-profile developmental programs.

M&S Tools

Numerous M&S tools already exist to support a program throughout the acquisition process. These tools include digital end-to-end simulation, virtual prototypes, cost models, force-on-force models, computer-aided design (CAD) and computer-aided manufacturing (CAM), and synthetic environments. Although most programs take advantage of M&S benefits, many people agree that the full potential of M&S has not been realized. The key to making SBA work is to integrate and effectively use M&S tools throughout the acquisition process in a distributed, simultaneous, and collaborative manner.

Commercial SBA Examples

One of the most heralded commercial programs that has included M&S in a manner that most closely resembles the goal of SBA, and one that has achieved significant savings while increasing system performance is the Boeing Company's 777 Commercial Airlifter Program.

Boeing management decided long before any sheet metal was bent to embark on a new engineering and manufacturing process, including a cultural change from the traditional aircraft development and manufacturing process. They decided to harness the power of high-speed computing platforms, along with advances in engineering software programs and telecommunications to create a virtual systems engineering enterprise. That effort interconnected thousands of computer workstations throughout the United States and Japan to create a system of data sharing and strict configuration management. This enterprise allowed for the complete and uninhibited sharing of critical data for the 100-percent digitally engineered and manufactured aircraft. Also, this data-sharing network provided the capability to perform aircraft preassembly on a computer, thus eliminating the need for physical mockups.

Additionally, Boeing took full advantage of a popular commercially available CAD software suite called Computer-Aided Three-dimensional Interactive Application (CATIA) to design and develop the 777, resulting in a 60- to 90-percent reduction in rework over previous similar commercial aircraft programs.

Many people are familiar with Chrysler's Dodge Intrepid Program. Breaking traditional automobile design and development process barriers, Chrysler evolved its development process to what it terms "cyber synthesis." Similar to the 777 Program, Chrysler management decided that all new automobile models would be designed and developed electronically with data sharing across the entire system development and manufacturing spectrum. This decision resulted in five new automobile models, three new V-6 engines, and cost savings of $75 million with a 20-percent reduction in development time.

Like Boeing, Chrysler used CATIA to create a "Digital Model Assembly." This assembly process enabled component and system packaging and design, and allowed side-by-side collaboration between development and plant engineers and product engineers from the outset of the Intrepid Program.

Unlike previous Chrysler programs, the Intrepid was designed in the same digital environment in which process engineers developed the manufacturing process. Although the system engineers conducted thousands more design iterations than they would have in traditional programs, no corners were cut and savings resulted. Obviously, the decision to harness the power and capability of CAD and CAM within a synthetic environment paid huge dividends for Chrysler—savings were realized and performance was enhanced.

Even the movie industry has "gotten into the act" with M&S, so to speak. Until recently, Hollywood special effects generally centered on animation and props. Now, by using sophisticated commercially available software, moviemakers are able to simulate realistic scenes that, in the past, were cost prohibitive or impossible to create.

The box-office hit, *Titanic*, used M&S throughout the movie. For example, special effects technicians created a scaled-down prototype of the ship based on actual specifications. Synthetic models of people moving about the ship with typical human behavioral characteristics were added. Finally, the modeled ship was placed in a synthetic ocean to create a scene of the *Titanic* steaming in the middle of the Atlantic Ocean with people interacting with one another on the deck. James Cameron, *Titanic* Director, said, "It is as close as you can get to being in a time machine, going back and being on that ship. All the accuracy and all the special visual effects are intended for one purpose: to put the viewer on Titanic. It's a very you-are-there kind of experience."

One of the objectives of SBA is to develop training simulations that provide an "immersed look and feel" for the user, giving a more lifelike representation of combat and combat systems. Just like in the movies, it will be important for soldiers to know that "you-are-there kind of experience." It is important for government and industry to capitalize on these technical accomplishments to make this happen.

One of the objectives of SBA is to develop training simulations that provide an "immersed look and feel" for the user, giving a more lifelike representation of combat and combat systems.

Military SBA Examples

The missile defense community applied some of the objectives of SBA long before it became an official DOD acquisition reform initiative. For example, the Patriot Advanced Capability-3 (PAC-3) Program included extensive live, virtual, and constructive M&S across the five functional areas of engineering development, combat development, test and evaluation, training, and exercise support.

As stated in the PAC-3's draft Simulation Support Plan, "Patriot M&S continues to be applied throughout the system life cycle in support of the program acquisition strategy. Specific acquisition activities to which M&S contributes include requirements definition, result prediction, compliance with performance-related Operational Requirements Document requirements, efficient test planning, pretest system checkout, testing and evaluation, force-on-force effectiveness analysis, deployment and defense design analysis relative to evolving threat scenarios, and manufacturing and logistics support strategies."

An example within the PAC-3 Program of an end-to-end process assessment simulation where multiple models are integrated into a multifunctional simulation suite is PAC3SIM. PAC3SIM is a digital, constructive simulation that integrates three previous models into one, creating the end-to-end capability that models system performance from emplacement through target intercept. PAC3SIM supports engineering development, combat development, and test and evaluation. PAC-3 performance predictions, gained through PAC3SIM, were presented during the Preliminary Design Review and Critical Design Review—a clear-cut example of how M&S, integrated throughout the acquisition process, performs crucial functions for key decisionmaking.

Of the more visible programs within the Army, the RAH-66 Comanche Program has included M&S throughout system development, which will result in savings during the life cycle of the program. In one specific case, it took 38 draftsmen more than 6 months to produce engineering drawings of the CH-53E Super Stallion aircraft's outside contours. The same effort on the Comanche Program took one engineer using M&S 1 month to accomplish. Also, by mandating the use of mission and engineering simulators, the Comanche Program Office team was able to examine operational characteristics. In addition, by designing for maintainability, they were able to reduce the necessary maintenance tools to fit into a small attache case.

The Army has also applied CAM extensively in the design, development, and operation of its chemical demilitarization plants. Specifically, the Army has used an industry-produced model of the Tooele Chemical Agent Disposal Facility (TOCDF) in Utah to conduct both operational and predictive reliability, availability and maintainability assessments of the plant. The TOCDF model allows for the establishment of a plant performance standard for use in comparisons of alternative facility, campaign, and process configurations. The model also will provide system developers indications of the effectiveness of plant improvements over time as a result of lessons learned.

Conclusion

Program managers should consider these commercial and government M&S examples when planning for M&S in an acquisition program. Integral to success is the determination by leadership to embrace the benefits of M&S, not just for comparative analysis in system testing and evaluation, but as critical tools for informed decisionmaking. Certainly, there are other examples (such as the Crusader, Improved Cargo Helicopter, and Follow-On To Tow) that take advantage of the full spectrum of M&S tools, including virtual prototypes, cost modeling, CAD, computer-aided engineering, CAM, and synthetic environments. These all provide good "jumping points" from which to begin an effective application of SBA. As time progresses and SBA gains "solid ground," many more examples will become available from which to learn and, likewise, enhance the application of SBA in the procurement of weapon systems.

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DIGITIZED COOPERATION WITH CANADA

LTC Ronald M. Janowski

"The path we have chosen strikes a balance between the present and the future."

William Cohen
Secretary of Defense
Quadrennial Defense Review
May 1997

Introduction

The U.S. Army Materiel Command (AMC) strongly supports international cooperative research and development (R&D) in accordance with federal law, economic efficiency, and political security. In this effort, AMC maintains U.S. Army Research, Development and Standardization Groups (USARDSGs) in several key allied capitals. Three USARDSGs have been in each of the three partner countries of the America-Britain-Canada-Australia (ABCA) agreement since its signing in 1964. Initially, the mission of the USARDSGs was solely to support ABCA standardization. In recent years, however, the USARDSGs' responsibilities have expanded to include the broader theme of identifying, promoting, and facilitating cooperative R&D opportunities with the host country in support of U.S. Army requirements. In addition to their two "sister" standardization groups in France and Germany, these five USARDSGs are AMC's "eyes and ears" into the military-industrial structures and capabilities of key global allies.

AMC Recognizes Opportunity

During past years, the USARDSGs' force structures have been adjusted to better match operational requirements. But as a result of the recent *Quadrennial Defense Review* and the ongoing revolution in digital communications, perhaps their greatest challenge is now underway as AMC will vacate both its Australian and Canadian offices in FY99 and FY00, respectively. It is vital to note here the choice of the word "vacate." AMC is not discounting its mission in international cooperation with these two allies, nor is it discontinuing the functions currently performed by these two offices. But AMC recognizes a unique opportunity at this time to leverage current technology and to transform these physical offices to virtual websites. In so doing, AMC

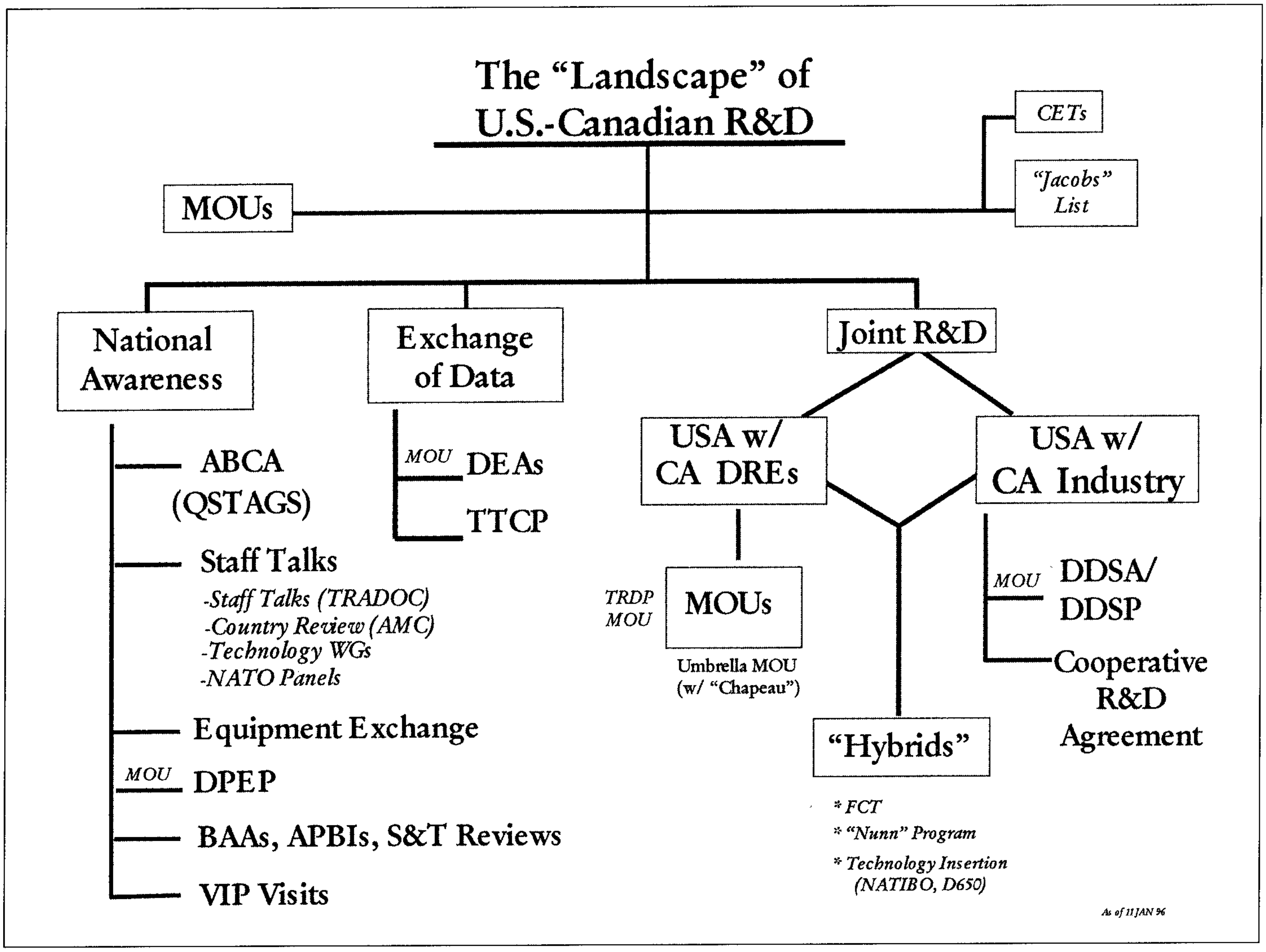

Figure Glossary

ABCA	America-Britain-Canada-Australia Agreement (1964)
AMC	U.S. Army Materiel Command
APBIs	Advance Planning Briefings to Industry
BAAs	Broad Agency Announcements
CA	Canadian
CETs	"Cutting-Edge" Technologies (Canadian "niches" of world-class research)
DDSA/DDSP	Defense Development Sharing Agreement/Program
DEAs	Data Exchange Agreements
DPEP	Defense Professionals Exchange Program
DREs	(Canadian) Defence Research Establishments
FCT	Foreign Comparative Testing
Jacobs' List	List of potential U.S.-Canadian cooperative projects
MOUs	Memorandums of Understanding
NATIBO	North American Technology and Industrial Base Organization
NATO	North Atlantic Treaty Organization
QSTAGS	Quadrilateral Standardization Agreements
S&T	Science and Technology
TRADOC	U.S. Army Training and Doctrine Command
TRDPs	Technology Research and Development Projects
TTCP	The Technical Cooperation Program (scientific sharing among ABCA)
WGs	Working Groups

looks to the Internet as a "force multiplier" to provide a virtual clone of the capabilities previously provided by a liaison officer, and to expand AMC's presence internationally by reaching out to any user having access to the World Wide Web. Certainly something is lost without a physical presence, and AMC retains the option to reoccupy its vacated offices in the future. But teleconferencing and "surfing the web" have become as routine as using the telephone and referencing a book. The time of the virtual office has arrived.

USARDSG-Canada Identifies Baseline Assumptions

Shortly after AMC decided to vacate its Australian and Canadian offices, USARDSG-Canada began "brainstorming" for an answer to the question of how its mission might continue following the office's transition from a physical structure to a virtual environment. A number of **assumptions** formed a baseline for the effort:

- *Valid mission into the 21st century.*

Given the upward spiraling cost of Defense R&D, the enticement of leveraging foreign monies will remain. But perhaps of greater importance is the political reality of the United States exercising its national power through future partnership operations that will benefit from standardization and cooperative R&D agreements. These twin factors of economics and politics will ensure continued international cooperation well into the foreseeable future.

• *R&D will drive international cooperation.* As costly as Defense R&D is, it is nevertheless based on a "graduated" cost process in which early research accounts for a low percentage of overall project cost, yet is high in its long-term impact on the final product. In general, U.S. Defense R&D funding is substantially more than that of potential allied partners. International cooperative ventures, therefore, offer allied partners the biggest "bang for the buck" in the earliest phases of a research project. During these phases, the partners can best influence future design in the most cost-effective manner without committing large portions of their resources. This practice will continue (if not expand) into the 21st century, thus establishing early research as the "bread and butter" of successful international cooperation.

• *Additional responsibility for the AMC action officer.* With across-the-board reductions throughout the Army, management of U.S.-Canadian cooperation will be just one of many duties for an AMC action officer (AO).

• *Access to e-mail and the Internet.* The digital revolution has relegated the telephone to a secondary role in the daily operations of an AO. If the AO is to effectively manage an AMC mission area, at a minimum, it will be via e-mail and the Internet.

Goals For Virtual Office

From this baseline, a set of **goals** for the virtual office emerged:

• *It should be as "self-functioning" as possible.* The virtual office must be a low-maintenance operation. Wherever possible, the virtual office must inform or provide guidance for the visitor to find the definitive answer to their question(s) at a linked site representing subject matter expert information. The virtual office must function nearly autonomously, with the AO periodically updating and reviewing site files to ensure accuracy, but otherwise engaged in more "management-intensive" duties.

The "exploding" presence and capabilities of the Internet provide us with a powerful tool that cannot be ignored.

• *It should be easy to use.* "User friendly" is no less appealing in international cooperation than it is in any other venture. Arguably, it is more so, as most projected customers are already "going the extra mile" in even considering international cooperation instead of the easier, though possibly more costly, domestic solution.

• *It should be accessible.* For many of the same reasons in making it easy, the virtual office must cater to the user in both use and access.

• *It should be a "one-stop shopping" directory for U.S.-Canadian cooperation.* The virtual office must strive to become what the USARDSG-Canada office has sought to be: a single site interested parties go to *first* to seek information regarding U.S.-Canadian cooperative R&D. The office does not claim to have all the answers, but does aspire to be the easiest "gateway" for either Americans or Canadians to seek direction or dialog that can ultimately lead to cooperative success. The goal of the virtual office must be no less.

A synthesis, then, of the assumptions and goals quickly defined the obvious solution: enhance the recently established office Internet "home page" into a comprehensive, user friendly, virtual clone of the physical office.

Key Questions

USARDSG-Canada is now deeply involved in this project. Key questions in the transition process include:

• How well does the current office website **http://www.amc.army.mil/amc/sra/intlpa/canada/homepage.html** fulfill the objective?

• To what **existing** websites does USARDSG-Canada need to hyperlink?

• Which important international cooperation "players" currently have **no existing** websites (but should!) for which the virtual office must provide a cyberlink "wedge" to account for a future hyperlink?

In the course of answering these key questions, USARDSG-Canada will develop the most crucial element for success of the virtual office, the actual design of the home page.

The figure at the top of page 28 shows the working base structure for the new home page. As envisioned, the "Landscape," which broadly outlines the operational scope of USARDSG-Canada, will become both a visual "table of contents" to the website visitor and a collection of hyperlinks to appropriate, related sites for each of the Landscape's subjects. Ultimately, the USARDSG-Canada website will become the single site to obtain information on all aspects of U.S. Army cooperation with Canada. Such a site will be highly useful, require little maintenance, and be supportable by AMC from literally anywhere in the world.

Conclusion

Like the rest of the Army and its sister Services, AMC faces the unprecedented challenge of doing more with less. Innovation must be the rule of the day. The "exploding" presence and capabilities of the Internet provide us with a powerful tool that cannot be ignored. By providing a virtual office, we propose to match the capabilities and benefits currently available at a remote single site. Such a site will continue AMC's dedication to supporting international cooperation among our allies and ultimately contribute to the establishment of a more secure environment for the global community of nations.

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Getting It Right The First Time . . .

THE ARMY MATERIEL RELEASE PROCESS

Thomas Dow

Introduction

What's more important than making sure we provide our soldiers with quality equipment that is supportable? For thousands of design engineers, testers, trainers, quality assurance technicians, contractors, supporting logisticians, and the program and project managers (PMs) of the U.S. Army, perhaps nothing is more important! But can it be that we work so hard to make sure we get it right the first time, that we introduce extra costs, inefficiencies, and fielding delays? That is what PMs and others suggested to the Department of the Army (DA) Office of the Deputy Chief of Staff for Logistics. As a result, a DA Materiel Release (MR) Process Action Team (PAT) assembled at Redstone Arsenal, AL, Sept. 12-14, 1995.

What's more important than making sure we provide our soldiers with quality equipment that is supportable? For thousands of design engineers, testers, trainers, quality assurance technicians, contractors, supporting logisticians, and the program and project managers of the U.S. Army, perhaps nothing is more important!

Composition Of The Team

The MR PAT included a representative cross section of the stakeholders involved in the MR process and others who provide certifications in the MR process. These include the Military Traffic Management Command Transportability Engineering Agency and the U.S. Army Test, Measurement, and Diagnostic Equipment Activity.

The MR PAT had to answer tough questions. Why is the MR process perceived as expensive, time-consuming, and hindering to the PM getting equipment fielded to the soldier in the field? Why is the MR process considered redundant to the type classification (TC) process? And most important, how can we streamline the MR process without jeopardizing the quality and supportability of the equipment fielded by the U.S. Army?

The first step by the PAT in streamlining the MR process was for each of the players in the process to explain their part to the other players. Each one identified their requirements, timelines, and contributions. Once all the pieces of the puzzle were there for everyone to see, recommendations for streamlining started to flow. Improvements in communication, training, coordination, and automation were identified. Changes in the level of release authority and in policies and procedures to guide the MR process were agreed on for immediate implementation or testing. In addition, the group agreed to meet again in 1996 to report on progress and to identify additional ways to streamline the MR process.

Initial Actions

The first MR PAT meeting, from a bureaucratic perspective, worked miracles because it galvanized a community of diverse functional organizations into a team of professionals with a common goal. It provided the vision that the MR process is an integral part of the system development and fielding process, not a tacked-on, non-value-added paper drill. The members of the PAT left with a feeling of empowerment and an appreciation for how their part of the MR process helps the other players. Five streamlining actions, outlined below, resulted from the first MR PAT meeting and set the stage for a follow-on meeting held July 23-25, 1996.

- The first action was a 1-year test to give MR approval authority to the Army Materiel Command (AMC) major subordinate command (MSC) commanders. (Nonconcurrence on a major system release could still be referred to the Commanding General, AMC.) This action alone saved 2 to 3 weeks processing time and has since been adopted as a permanent policy change.
- The second action was that release documentation was reduced and consolidated from 19 certifications to 10.
- The third action was increased use of electronic media for providing information and responses in the MR process, resulting in reduced processing times.
- Fourth, MR coordinators at the AMC MSCs developed training packages to educate PM offices and other stakeholders in the MR process, ensuring all players understand what happens and when.
- Finally, changes to DA Pamphlet 700-142, *Procedures for Materiel Release, Fielding, and Transfer,* were developed to reflect the streamlining actions.

Is the materiel release process perfect yet? No, but it is no longer costly and cumbersome, and we can get it right the first time.

Second MR PAT Meeting Actions

The second MR PAT meeting was a lively, success-oriented meeting that reported on improved MR process coordination and reduced processing times. It also examined the MR process further, resulting in a number of additional ideas for streamlining. The group agreed to institute the following:

- Include MR coordinators as part of each new system Integrated Process/Product Team (IPT), and have them brief the IPT on the MR process and help plan, schedule and coordinate all releases;
- Require MR coordinators to add materiel release information to their command's home page;
- Clarify and eliminate overlap between MR and TC documentation requirements;
- Allow the use of TC documentation for MR when still applicable;
- Combine TC and MR for nondevelopmental items (NDI) when requirements for MR can be met before Milestone III;
- Eliminate the requirement for a conditional release of a system when conditional release of Associated Support Items of Equipment (ASIOE) is the only reason for the conditional release;
- Eliminate the requirement for an "Urgency of Need Statement" from the gaining major Army command (MACOM) when planned interim contractor support is the only reason for a conditional release; and
- Update DA Pamphlet 700-142 to include a section portraying the typical MR timeline and events.

Conclusion

The old complaints about the MR process are no longer valid because the MR process has been integrated into the acquisition process as never before. The players know each others' requirements and capabilities and are coordinating extremely well. Is the MR process perfect yet? No, but it is no longer costly and cumbersome, and we can get it right the first time. A third MR PAT meeting is planned for 1998 to report on progress and discuss any additional opportunities to further streamline the MR process.

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ON-THE-JOB SUSTAINMENT TRAINING FOR MILITARY FOREIGN LANGUAGE SKILLS

Dr. Jonathan D. Kaplan and COL Steven A. LaRocca

Introduction

The acquisition and sustainment of foreign language skills has been a long-standing problem for global military readiness. Foreign language skills are notoriously perishable, and maintaining proficiency in critical languages is difficult and costly. An underlying problem is that the 11,000 military linguists who need to receive sustainment training on a recurring basis are scattered throughout the world, making centralized instruction infeasible.

Linguists receive their sustainment training by spending up to 2 weeks on TDY in-country, and depend on live instruction, a source of considerable continuing expense. Clearly, if a viable approach can be developed, a technological solution for sustainment training at the jobsite could be a cost-effective alternative, and offer realistic, interactive practice, such as exercises for written or spoken dialogue. The Military Language Tutor (MILT) was designed to fill this need.

MILT is a military foreign language tutor and an authoring system. MILT combines the strengths of previous computer-based approaches to language training with emerging technologies from the fields of computational linguistics, computer science, and electrical engineering. The result is an innovative, interactive tutor in a Pentium-based laptop computer.

Design Goals

The first version of MILT with keyboard input was designed for Spanish and Arabic, and can recognize tens of thousands of common words and hundreds of military terms in each of these languages. Its major software engine is a natural language processor. The goal of the MILT design team was to deliver an authoring system that requires no formal external training and could be learned within 4 hours by anyone familiar with the Windows operating system. It was envisioned that even someone with no programming experience, using only documentation and internal MILT help functions could use it. In MILT discrete speech recognition (DSR), students are given an exercise that allows them to use language production to manipulate a graphics "microworld." Based on the interest of the Special Operations Command (SOCOM), the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences and the Department of Defense (DOD) Office of Special Technology developed a proof-of-principle version of the Arabic microworld that uses DSR rather than keyboard input to solve an authored problem.

The U.S. Military Academy's Foreign Language Department provided expertise in the development of Arabic acoustic and language models for continuous speech recognition (CSR) and, as part of the project, created the first speaker-independent Arabic CSR for educational purposes.

Evaluation

A pilot test of this proof-of-principle version of the Arabic MILT was conducted at ARI during April-May 1997. Using Fifth Special Forces Group (SFG) personnel at Fort Campbell, KY, a field evaluation was conducted in early June 1997. Two types of data were collected: student attitudes toward the tutor, and instructional effects of the tutor. Information identifying specific revision needs was collected from students via written surveys and the evaluator's observations of their performance on the tutor. Attitude survey questions concentrated on the microworld.

To measure the effects of tutor use on language proficiency, pre- and post-test measures were taken. Translation tests consisted of written English versions of the 70 microworld command utterances and instructions to speak them in Arabic into a tape recorder. These tape cassettes were later rated by an Arabic linguist, who is a native speaker. Unaware of the speech source, he rated each recorded utterance on four dimensions: vocabulary, grammar, pronunciation, and overall fluency. The same procedures were used for both pilot and field evaluations.

On attitudinal measures, the results from both tests were positive. The trainees enjoyed the experience and would like to use the microworld approach in the future. The results from the SFG trainees on instructional effectiveness also agreed with the results from the pilot study: *The rated translation scores for vocabulary, grammar, pronunciation, and fluency dramatically increased after an hour's exposure to MILT.* The greatest improvement was in those participants whose prior skill in Arabic was intermediate. This group represents the population for whom the MILT was designed. This indicates that a cost-effective solution to the language sustainment problem is now a possibility.

The Next Phase

In the next phase, an authorable dialogue capability will be embedded in a 3-D, graphics-based mission rehearsal tutor with full speech recognition and generation capabilities. CSR will be added to allow soldiers to practice their dialogue-oriented missions in a virtual environment, interacting with a computerized dialogue partner that will play a role assigned by the author. The students will move in a 3-D world, while communicating with the modeled dialogue partner regarding task-relevant information. Artificial intelligence will be used to organize the information into a knowledge base.

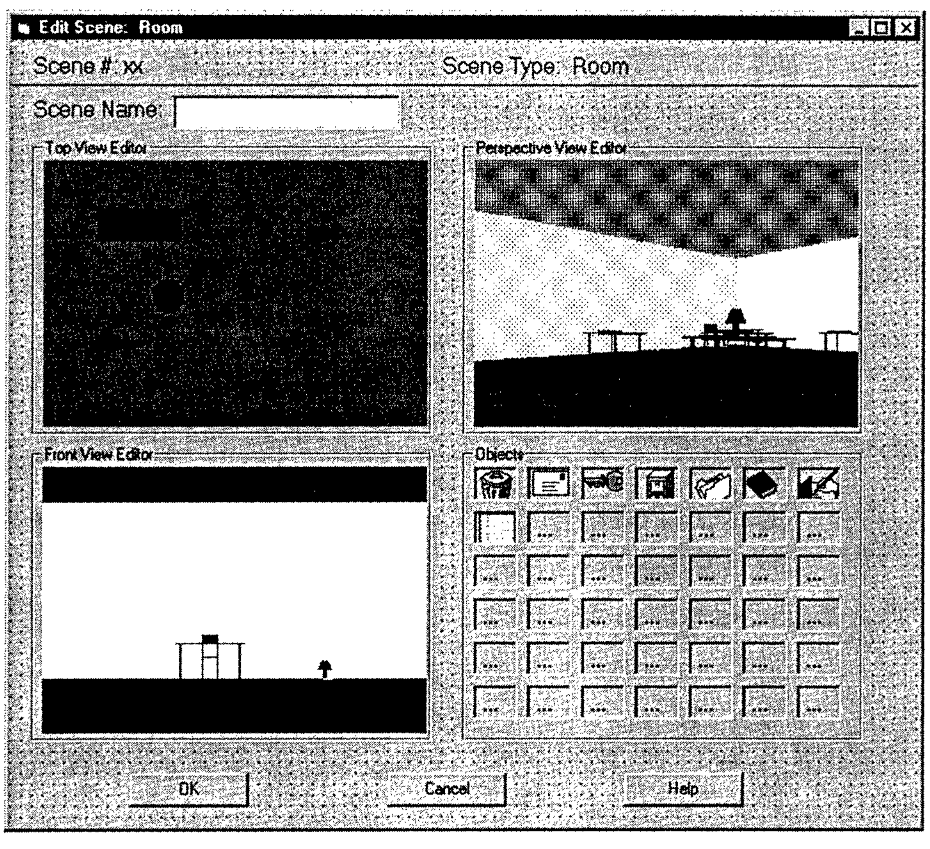
The authoring system will allow non-programmer, domain experts to create knowledge bases with a minimum of training and effort. One will be able to produce a simulated foreign language experience modeled on anticipated tasks with a high degree of realism that can be played repeatedly as practice.

The accompanying figure shows the scene editor interface that allows an author to select a 3-D object and place it in a given microworld scenario. The window at the lower right of the scene editor contains thumbnail graphics of all selectable objects. The window at the lower left allows authors to do vertical placement of objects. The window at the upper left provides a top-down view and allows authors control of the horizontal and depth dimensions of the objects. The window at the upper right provides authors with a real-time, 3-D view so they can examine and rotate a given room or outside space.

Research issues will be studied to improve the effectiveness of the new tutor. They include varieties of voice feedback related to acoustic modeling; transfer to speaking, listening, and reading from keyboard entry practice; effectiveness of natural language processing on its own, CSR on its own, or a combination of the two; and cross training on specific levels of comprehension (surface, reference, and inferential).

Conclusion

Finally, from the beginning of the MILT project, practical product development and user needs have guided the research and development effort. Concurrently, partnerships with other agencies have provided testbeds for evaluations and resource support integral to the success of the project. As a result, significant and useful products have been provided to the U.S. Army Training and Doctrine Command, the SOCOM, and other DOD organizations. In addition, key MILT components are being integrated into the new Unicode-based Global Language Authoring System. This approach will continue to focus the research on practical applications of cutting-edge technology.



Three-dimensional scene editor.

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Future Army Missile Systems . . .

MICROELECTROMECHANICAL SYSTEMS: AN EMERGING TECHNOLOGY

Dr. Paul Ruffin and
William Pittman

Introduction

Department of Defense (DOD) downsizing has put a stronger emphasis on using commercially developed technology for military weapon systems. Coincident with the downsizing of the Army is the emergence of new mission assignments in peacekeeping and in operations other than war that require small-diameter, precision-guided weapons that complement the larger weapons for "killing" tanks.

A technology planning team in the Missile Research, Development, and Engineering Center (MRDEC) at the U.S. Army Aviation and Missile Command has identified microelectromechanical systems (MEMS) as a key emerging technology to support MRDEC's mission of developing weapons to kill tanks. MEMS technology holds the promise of reducing the size, weight, cost, and power requirements of Army missile systems, as well as providing opportunities for new computing, sensing, and actuation functions that cannot be achieved with conventional electromechanical technology.

Strategy

MEMS is a dual-use technology based on academic research and device fabrication development in both industry and the government. Therefore, the centerpiece of the MRDEC strategy is to capitalize on the cooperative efforts of the private sector and the government. Figure 1 shows the key elements of the MRDEC mission and key application areas for MEMS within these mission elements. Some elements of the MRDEC strategy for exploiting MEMS technology programs are shown in Figure 2.

The MRDEC plans to integrate MEMS technology into weapon systems applications for improved performance and cost reduction. To reduce the development time for MEMS, the MRDEC is including MEMS devices in technology demonstration (TD) programs, and gaining knowledge through in-house technology programs, small business innovative research programs, and through partnerships such as the DOD/Department of Energy (DOE) Munitions Program at Sandia National Laboratory, Albuquerque, NM. The MRDEC is also the lead agency for the Munitions Program, which is focusing on MEMS Inertial Measurement Technology.

MEMS is a dual-use technology based on academic research and device fabrication development in both industry and the government.

The MRDEC Manufacturing Technology Office is striving to leverage efforts sponsored by the Defense Advanced Research Projects Agency (DARPA), DOE, the Army Research Office, and others to obtain cost-effective MEMS manufacturing methods. The MRDEC has been involved in microfabrication development for more than 15 years and has a joint laboratory facility with the Marshall Space Flight Center, National Aeronautics and Space Administration, which includes optical and E-beam lithography, reactive ion etching, thin film deposition, and submicron device design and analysis capabilities.

Near-Term Applications

Presently, MRDEC is researching MEMS-based missile inertial sensors, optical encoders, and radio frequency (RF) multilevel switches. A brief description of each follows:

Inertial sensors. MEMS technology has the potential to reduce the size and cost as well as improve the perfomance of small-diameter, precision-guided weapons, such as the Low Cost Precision Kill (LCPK) 2.75-inch Guided Rocket and small hypervelocity missiles.

As presently envisioned, the LCPK rocket will have two angular rate sensors and a roll gyroscope. The roll gyroscope must sense clockwise and counterclockwise rotations while the rocket spins at up to 30 Hertz in both directions. As MEMS technology matures and MEMS gyroscopes become available, complete three-axis stabilized platforms may be feasible for the LCPK.

Developers of the Compact Kinetic Energy Missile (CKEM) TD Program for Line of Sight Anti-Tank Preplanned Product Improvement are initiating insertion of advanced hypervelocity component technology into missile systems. The CKEM inertial sensors must operate through, rather than simply survive, a missile-boost environment of up to 800-g. MEMS accelerometer technology has the potential of measuring the wide dynamic boost range (milli-g to kilo-g) of hypervelocity missiles and gun-launched munitions.

Optical encoders. The LCPK currently uses an actuator with an arc segment potentiometer to measure canard position. The potentiometer measures canard position from minus 20 degrees to plus 20 degrees with an accuracy of plus or minus 0.4 degree. Digital measurement of the actuator position can be achieved using an optical encoder. The optical encoder's digital output eliminates the need for an analog-to-digital converter, reducing device size and the complexity of actuator electronics. In addition, the digital position measurement is free of detrimental "electrical noise." Optical encoders, however, fabricated by conventional methods are significantly larger than potentiometers. Using MEMS technology, MRDEC is researching potential fabrication of a miniature optical encoder for actuator position measurement that will meet the LCPK requirements.

RF multilevel switches. A near-term application for RF switches at MRDEC is for multilevel switching of RF signals within arrays of antennas in MRDEC's RF hardware-in-the-loop simulation facilities. Wide RF bandwidth, high-power handling, good isolation, and high-speed switching capabilities are required. Based on initial performance results, MEMS RF switches appear to be potential candidates for this role. Additionally, there is further potential for RF switches within missile RF seeker applications, where size and cost are critical features.

Future Applications

Future MEMS-based applications include the proposed Remote Readiness Asset Prognostic/Diagnostic System Advanced Technology Demonstration Program, whereby a suite of sensors is integrated into the weapon system to remotely identify a missile's

How MEMS Technology Relates to the Mission of the Missile Research, Development, and Engineering Center

Mission Element	MEMS Application
• Lead Laboratory for Guidance and Control and Terminal Homing	• Inertial Navigation for Missiles & Vehicles • Microjet Arrays for Enhanced Propellant Mixing • Combat Identification
• Life Cycle System Engineering	• Condition Based Maintenance • Remote Monitoring of Missiles in Storage • Environmental Sensors
• Lead Laboratory for Rocket Propulsion	• Active Conformal Surfaces for Aerodynamic & Propulsion Control
• Embedded Computers for Weapon Systems	• Mass Data Storage for Automatic Target Recognition
• All Mission Elements	• RF Switches • MEMS Manufacturing Process Development • Weapon Safing, Arming, & Fuzing

Figure 1.

Missile Research, Development, and Engineering Center MEMS Strategy

- Exploit MRDEC Partnerships in
  - DARPA/DOE MEMS Programs
  - DOD-DOE Munitions Program
  - Packaging Research Center Consortium (Georgia Tech)
- Small Business Innovative Research Program
- Cooperative Research and Development Agreements
- Bailment Agreements
- Technology Base Program
- Support to the Program Executive Office for Tactical Missiles and Missile Defense

Figure 2.

The rapidly emerging field of MEMS-based technology holds the potential for a plethora of sensor and actuator applications in the military and commercial sectors.

current and past condition, and to predict its readiness for combat. The sensor suite will contain the following types of sensors: environmental, chemical, fuel flow, engine revolutions per minute, electromagnetic interference, security, and others. Sensors to monitor environmental conditions, chemical status of the propellant, and structural integrity of the solid propellant rocket motor could be attached or embedded in the shipping container, launch canister, and in the motor itself. Currently, the rocket motor surveillance system consists of selecting fielded motors and conducting destructive testing. This is not only expensive, but is based on the assumption that the sample is representative of the rocket motor inventory. By employing MEMS sensors, the rocket motor inventory can be nondestructively monitored with more accurate projections of the motor's life expectancy.

The MRDEC also has a number of potential applications that will require the merging of optical and millimeter wave technology, including dual-mode millimeter wave and infrared sensing for long-range, fiber-optic guided (LONGFOG) missiles. The proposed LONGFOG platform features an infrared imaging seeker on a fiber-optic guided missile that will have the capability to strike at targets as far away as 100 kilometers or more. As the missile flies rapidly to the target, scenes from the infrared imaging seeker will be transmitted over high-bandwidth fiber to the ground for combat identification. The addition of a MEMS-based adaptive optical system to the LONGFOG seeker to compensate for fluctuating wavefront distortions that blur images when viewed through a turbulent atmosphere, such as cloud cover, would provide a capability for attacking obscured, high-value targets. An adaptive optic system typically consists of a wavefront sensor to detect optical aberrations, electronics to compute a corrective solution, and a deformable mirror device to apply the correction. A silicon adaptive optics system employing MEMS deformable mirrors integrated with micro-optics and electronics would provide for a solid-state, integrated adaptive optics system.

Other potential MEMS-based applications for missile systems include microjets to control the boundary flow layer surrounding missiles and unmanned aerial vehicles to reduce drag and to improve lift, control, and noise suppression. Microjets could be used to add energy to the flow and reduce separated flow regions that cause high drag. MEMS technology could also be applied to devices that add energy to the flow by mechanically moving at specific frequencies, thereby increasing turbulence and reducing separated flow regions or delaying the onset of laminar to turbulent flow in some cases. Microsuction devices could also be used to delay the transition from laminar to turbulent flow. These technology advancements could provide for increased range, reduced minimum operating velocity, and decreased acoustic signatures.

Army missiles also present requirements associated with fuzing and safety and arming (S&A) devices. For example, an S&A device can be separated into three parts: launch and flight environment sensors, safety logic, and explosive train. The launch and flight environment sensors and a fail-safe logic (mechanical logic) that arm the explosive train are two sections of an S&A device that are suitable for MEMS applications. MEMS technology is ideal for S&A devices that require low-cost devices and/or have unique flight environments. Most mechanical S&A devices use acceleration to develop the forces needed to operate mechanical safety logic. Low-flight acceleration, however, is common in missiles, and the potential mechanical forces can be very small, thereby complicating the design of the S&A device. MEMS accelerometers have the potential to overcome these problems via rugged designs.

Conclusion

The rapidly emerging field of MEMS-based technology holds the potential for a plethora of sensor and actuator applications in the military and commercial sectors. A MEMS Integrated Product Team has been formed within MRDEC to focus on MEMS technology and to implement this technology where possible. Concerted efforts must be conducted to make MEMS devices capable of withstanding shock, vibration, varied temperatures and humidity, and long-term storage conditions often encountered by Army missile systems.

To address the future potential of MEMS-based applications, the MRDEC must work diligently with other government agencies, academia, and industry to translate the vast potential of MEMS technology to next generation Army weapon systems. The ultimate goal of the MRDEC MEMS effort is to provide the most technologically advanced warfighting systems to the soldier in the field.

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PERCEPTIONS OF AN I-GRAD PROGRAM PARTICIPANT

MAJ David E. Schoolcraft

Introduction

In November 1997, the Department of the Navy completed negotiation of a Cost Plus Incentive Fee type contract for a V-22 Full Flight Simulator (FFS) valued at more than $34 million. The contract was awarded to the team of Bell Helicopter Textron Inc. (BHTI)/Boeing Company Information Space and Defense Systems (hereafter referred to as Bell-Boeing). Delivery will be at the Marine Corps Air Station, New River, NC, on or about July 31, 2000, with the simulator ready for training no later than Dec. 31, 2000. As a student officer in the Industry Graduate (I-GRAD) Program at the University of Texas at Arlington (UTA), I worked on the V-22 FFS proposal submitted to the Navy. Specifically, I worked at BHTI in the V-22 Contracts Department as part of my program of work in pursuit of a master of business administration (M.B.A.) degree from UTA.

What exactly is I-GRAD? It is a program established for military officers that combines a traditional M.B.A. with the Training With Industry (TWI) Program. Students in the I-GRAD Program do not receive TWI credit from the military but do receive all the actual, hands-on experience of a TWI Program. The I-GRAD student attends the university full time for the first year. Subsequently, the student works in one of the areas' several Defense firms for 9 months while attending night classes at the university. I-GRAD is in its fourth year with students currently working at Lockheed Martin Vought Systems and BHTI. They receive 9 hours of academic credit from the university for their TWI work experience. There are three students in their second year of the program and five in their first year.

I-GRAD offered me the chance to get an M.B.A. and to see contracting from a contractor's point of view. I chose BHTI's V-22 Contracts Department as the place to hang my hat for two reasons. First, I am an FA97 (contracting and industrial management) officer and one of the contract departments at BHTI was a logical place to work. Second, the V-22 Contracts Department works on multiservice contracts and I was exposed to the way the Navy, Air Force and Marines run their programs and carry out contracting. It was a golden opportunity to observe, participate and learn new or improved ways of doing business that I can now apply to my first contracting assignment. I was fully integrated into their daily activities and performed all of the duties of the department with the exception of negotiations with the government on prime contracts. The department went out of its way to show me how BHTI conducts business. I was even given my own projects that ranged from preparing rough order of magnitude requests, conducting estimate request kick-off meetings, developing sales order releases, to actual proposal preparation and submittal. I also witnessed the daily challenges of teaming with another Defense contractor on a major aviation program. As a result of my experience at BHTI, I learned the acquisition lexicon, and witnessed many of the acquisition reform initiatives used on a daily basis. One example of my integration into the department was my participation on the V-22 FFS proposal.

FFS History And Initiatives

The FFS Program initially began as a traditional acquisition program to be based on detailed military specifications. In April 1997, the Department of the Navy requested Bell-Boeing submit a proposal for an FFS and that Bell-Boeing follow the Perry [former Secretary of Defense William H. Perry] Initiatives as much as possible in their request for proposal (RFP) submittal. The result was an RFP submitted in November 1997 based on performance specifications (not military specifications) and included commercial off-the-shelf (COTS) design, and full life cycle contractor logistics support (CLS).

Other initiatives of the program include a dedicated website (password protected and encrypted) for use in design and data management, and the use of a collocated Integrated Product Team (IPT) with government representation throughout the development process. Additional initiatives include commercial configuration management that maintains configuration to a functional baseline and accepts parts obsolescence as a fact of life, and a nontraditional operational support data package (OSDP). Operation and maintenance manuals are in a commercial format with all drawings being the actual engineering drawings used to produce the device and maintenance manuals.

Commercial Approach To Development

The performance specification for the MV-22B (Marine Corps variant) Osprey FFS is 31 pages (including appendices) of the "what" instead of the "how" of traditional military specifications. The motion-based simulator, which will be built by Flight Safety International (FSI) of Broken Arrow, OK, will be comparable in performance and training capability to a simulator developed under Federal Aviation Administration (FAA) regulations for simulators, but will not be certified by the FAA.

The FFS will be comparable to FAA

level D simulator standards for both helicopter and airplane simulator qualification as provided in FAA Advisory Circulars 120-63 and 120-40B. Currently, the FAA has not defined simulator qualifications for tiltrotor characteristics and operation. For this reason, appropriate requirements from both FAA fixed- and rotary-wing aircraft circulars were included in the performance specification. Plans call for the FFS to follow the design philosophy of a commercial simulator and fully support all of the simulator training events of the training and readiness syllabus for the MV-22B as established by the Marine Corps.

The FFS will replicate the functional design basis of the aircraft that is low-rate initial production Lot 1 Aircraft 11. *The Qualification Test Guide*, developed in accordance with advisory circulars, shall serve as the archival record of FFS performance and as the acceptance testing procedure for delivery. The program seeks maximum leverage of nondevelopmental technology and trainer commonality to hold down costs in the eventual planned "family" of MV and CV (Air Force Special Operations Forces variant) simulators to include up to three FFSs and four flight training devices (FTDs) (non-motion based).

Technical Approach

Bell-Boeing, FSI, and the government are a technical excellence team, which uses a collocated IPT and a dedicated website to facilitate development, data management, and to reduce costs and risk. Bell-Boeing provides integration of the aircraft elements, aircraft math model, 1553 Data Bus, and production aircraft avionics; FSI provides all remaining integration and hardware. The government provides the AN/AVS-7 NVG/HUD system, the Marine Corps Common Visual Database, other elements of government-furnished information, and overall program insight versus oversight. Actual aircraft avionics or reasonable facsimiles will be used to present a realistic training experience, facilitate use of "drop in" avionics software to "drive" aircraft avionics, and keep the training system updated as new aircraft software drops occur.

Operational Support Data Package

The OSDP is a nontraditional technical data package that will consist of whatever data is necessary to provide the required support to the simulator. The data and drawings will be in a commercial format with all material government-owned and available to the government at its request for the cost of reproduction. As previously stated, all drawings are engineering drawings used to produce the simulator and the maintenance manuals. This reduces costs, simplifies maintenance, and facilitates future updates as training system updates are performed. This data package will serve as the baseline and will support any future devices (FFSs, FTDs and any aircraft variant) with differential data for each variant identified and incorporated during production of follow-on devices.

The OSDP will include the following: operation and maintenance manual (including an FFS system schematic), the planned maintenance system documentation, COTS documentation, and the *Training System Utilization Handbook* (all in the commercial format of the contractor). The initial operational test and evaluation period (IOTEP) will provide a real-life 6-month test of the integration of the OSDP into the device life cycle support by establishing the usability, effectiveness, and thoroughness of the OSDP deliverables in their intended operating environment.

Logistics Support

Integrated logistics support is provided from contract award through completion of IOTEP. Starting with the completion of the IOTEP, CLS for 1 year has been included in the FFS contract with the option for additional CLS to be negotiated in each subsequent year. During CLS, the FFS Team is responsible for all operations, repairs, and maintenance (less instruction) to include storage and inventory, and data maintenance. The trainer availability requirement is 95 percent, based on 16 hours a day, 5 days a week, 50 weeks a year for the operating life of the FFS (20 years or 80,000 hours).

Conclusion

This proposal provided a stimulating learning experience for me. The technology, strategy and business basics for this proposal taught me to appreciate the contractor's decisionmaking process and how it evolves. The I-GRAD Program at UTA offers Acquisition Corps members the opportunity to combine the benefits of a traditional M.B.A. program with the experiences of the TWI Program. UTA is centrally located within the Dallas-Fort Worth metroplex, which is home to several Defense contractors. I recommend the I-GRAD Program to everyone who wants to expand their realm of thinking and to avail themselves of this rich opportunity.

The Industry Graduate Program at the University of Texas at Arlington offers Acquisition Corps members the opportunity to combine the benefits of a traditional M.B.A. program with the experiences of the Training With Industry Program.

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STIMULATING SOFTWARE REUSE THROUGH IMPROVED ACQUISITION PROCESSES

Tara Ragan

Introduction

The U.S. Army Space and Missile Defense Command's (USASMDC) Advanced Technology Directorate is managing an effort to promote adoption of product line, architecture, and software reuse concepts. This is being accomplished through development of products and services aligned with Software Acquisition Capability Maturity Model (SA-CMM) related process improvement activities. This Ballistic Missile Defense Organization's (BMDO)-sponsored Small Business Innovative Research (SBIR) Program has been directed at developing and piloting changes to the SA-CMM that stimulate increased software reuse through revised and improved acquisition practices. Such practices are aimed at helping acquisition organizations incorporate reuse concepts into their decision processes and products throughout the acquisition life cycle.

Ultimately, this effort will produce the products and services (e.g., model processes, tailoring guidelines, tools, training materials, technology transfer kits) to successfully achieve this beneficial paradigm shift. As a result, acquisition organizations will benefit from lower system life cycle costs and improved control of programs via better management of software acquisition processes.

Level	Focus	Key Process Areas
5 Optimizing	Continuous Process Improvement	• Acquisition Innovation Management • Continuous Process Implementation
4 Quantitative	Quantitative Management	• Quantitative Acquisition Management • Quantitative Process Management
3 Defined	Process Standardization	• Training Program • Acquisition Risk Management • Contract Performance Management • Project Performance Management • Process Definition and Maintenance
2 Repeatable	Basic Acquisition Management	• Transition to Support • Evaluation • Contract Tracking and Oversight • Project Management • Requirements Development Management • Solicitation • Software Acquisition Planning
1 Initial	Competent People and Heroics	

The Software Acquisition Capability Maturity Model key process areas.

Paradigm Shift

A paradigm shift has occurred in the way systems are being built. As more systems are developed to open system standards, products once constructed from scratch using custom designs are being replaced by product lines containing large quantities of commercial off-the-shelf (COTS) hardware and software components. To keep pace with these changes, the Software Engineering Institute (SEI) is in the process of changing the Software Capability Maturity Model (SW-CMM), the framework many government and commercial organizations use to assess the maturity of their software processes, to include product line, architecture and software reuse concepts. Unfortunately, the SA-CMM, a sister framework to the SW-CMM, hasn't kept pace with the advances that the SW-CMM has been making in these areas.

The SA-CMM is an ordered collection of "best practices" for the acquisition of software-intensive systems, and has an architecture very similar to the SW-CMM. The accompanying figure illustrates the structure of the SA-CMM. The SA-CMM describes the processes to acquire and sustain software, and it provides a framework to benchmark and improve an organization's software acquisition processes. Such organizations include government program offices and commercial firms that contract for software or buy it via strategic partnerships.

Phase I

The objective of the Phase I SBIR effort with Reifer Consultants Inc. (RCI) was to recommend changes to the SA-CMM that promote widespread use of advances made in product lines, architectures, and software reuse within industry and government software acquisition organizations. A detailed analysis of the SA-CMM was performed to determine what software reuse concepts were needed by organizations to manage acquisition of their software. As a result of this analysis, 34 changes to the SA-CMM framework were recommended.

The proposed changes were peer reviewed by a group of software reuse experts from SEI, government, industry, and academia at the Reuse '97 Workshop in Morgantown, WV. The group endorsed the proposed changes and they were submitted to SEI for incorporation into the next release of the SA-CMM.

Piloting Recommendations

To verify that the recommended changes to the SA-CMM stimulated increased reuse, organizations in government and industry were sought for participation in quick-look appraisals. It is interesting to note that few of the program offices approached for pilot participation were interested in conducting a complete, formal appraisal. They were either too busy or did not have the staff to support the formal appraisal process. They were also concerned about the increased workload and scrutiny that could result from the appraisal findings. Although appraisals were hard to obtain, the effort was successful in getting four projects to participate.

An appraisal questionnaire with the recommended changes to the SA-CMM was developed and used for "quick-look" assessments of the acquisition processes used by the four pilot projects: two from Northrop Grumman and two from U.S. Army Program Management Offices. These appraisals validated that the changes recommended to the SA-CMM are valuable and stimulate increased reuse. They had the added benefit of providing the pilot projects with constructive improvement recommendations in areas other than software reuse. All four projects were pleased with the appraisal feedback. The appraisals also proved useful in identifying priorities for candidate products and services that will be developed during the Phase II effort.

Market Outlook

In parallel with these activities, a market survey was used to canvass industry and government to determine the size and characteristics of the market for prospective SA-CMM products and services. The objective was to make sure that what was proposed for development during the Phase II SBIR effort had high commercialization potential. Using the survey results, a business plan was developed to show investors the potential returns if they elected to fund future activities. As such, Northrop Grumman elected to partner with RCI, and Phase I Fast Track and Phase II funding was secured from the BMDO sponsor.

Phase II

Based on the results of the market survey and the piloting efforts, a strong requirement appears to exist for the following SA-CMM products and services. Most of these products and services will be developed during the Phase II SBIR effort:

- *Model Software Acquisition Processes.* Model software acquisition management processes that respond to user requirements need to be developed for each identified market segment. Specifically, model processes are needed for the following SA-CMM key process areas: software acquisition planning, solicitation, and evaluation. Another area that needs model processes is COTS management. Although COTS management is not specifically addressed in the SA-CMM, it is the most pressing area where additional guidance is needed.
- *Tailoring Guidelines.* Related tailoring and scaling guidelines are needed so organizations can apply the model processes within their operations.
- *Software Acquisition Education and Training.* A variety of course materials are needed to persuade program managers and executives to embrace the SA-CMM. Development of practitioner skills and knowledge in the model processes and tailoring guidelines is also needed.
- *Appraisals.* Appraisals need to be conducted to identify organizational strengths and weaknesses relative to the requirements of the SA-CMM. Organizations may also need help in developing improvement plans that respond to appraisal findings.
- *PC-Based Tools.* A hypertext-based set of tools that run on a PC are needed to help users tailor model processes to their needs using the tailoring guidelines.
- *Technology Transfer Kits.* Information needs to be packaged on CD-ROM "kits" so potential users of the SA-CMM can quickly develop the know-how to use the technology.
- *Consulting.* Users may need help in using the products and services listed above to develop and assess their software acquisition management process improvement plans.

Conclusion

In summary, Phase I demonstrated the feasibility of stimulating increased reuse by adding product line, architecture and software reuse concepts to the SA-CMM. The Phase I effort also demonstrated that there is a market for related goods and services. The pilot appraisals conducted during Phase I helped identify needs, priorities and requirements for Phase II. During Phase II, products and services will be developed and their value demonstrated by continued beta testing on pilot projects. Government and industry acquisition organizations are encouraged to participate in the Phase II effort. Participation can be in the form of an appraisal and/or piloting the use of the model processes, guidelines, training materials, tools and/or technology transfer kits. Interested organizations should contact the USASMDC Advanced Technology Directorate: U.S. Army Space and Missile Defense Command, ATTN: SMDC-TC-AS (Tara Ragan), P.O. Box 1500, Huntsville, AL 35807-3801, or phone 205-955-3515 or DSN: 645-3515, or e-mail: **ragan@smdc.army.mil**.

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BATTLEFIELD AWARENESS AND DATA DISSEMINATION

Michael P. Orr and
Ameet R. Bhatt

Introduction

The Defense Advanced Research Projects Agency, under a 5-year Advanced Concept Technology Demonstration (ACTD) program known as Battlefield Awareness and Data Dissemination (BADD), is leading the development of an information management component for deployed strategic and tactical command, control, communications, computer, and intelligence (C4I) systems. The BADD Program is organized into three phases. The developmental phase (Phase I) led to BADD participation in two Army Advanced Warfighting Experiments (AWEs): Task Force XXI (TF XXI) and Division XXI. Phase II, with three stages, will provide a user service: wideband delivery, information management, and battlefield awareness. Phase III will transfer technology to the Department of Defense (DOD) Information Dissemination Management (IDM) Program. Through BADD, the warfighter's ability to request, receive and process information, as well as the broadcast center's ability to disseminate the needed information, will be greatly enhanced.

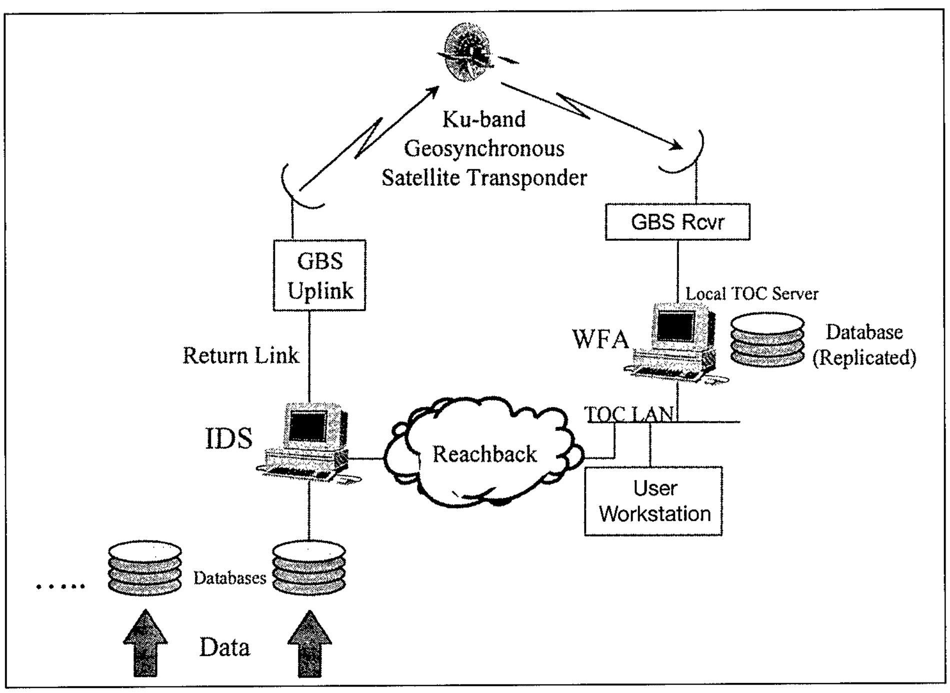

Figure 1.
The global broadcast service Battlefield Awareness and Data Dissemination architecture.

BADD ACTD Objectives

The primary objective of the BADD ACTD is to provide an information dissemination and management system that allows joint tactical systems to transmit and receive high-volume data by using cost-effective, commercially available technologies. Some of these technologies include the global broadcast service (GBS), asynchronous transfer mode, multimedia databases and their associated applications, uniform access to heterogeneous databases, automated information discovery, scaleable architecture, an efficient message handling system, single-source and multisource correlation, signal intelligence product exploitation, IDM, and situation and intelligence assessment.

GBS/BADD Architecture

In the GBS/BADD architecture (see Figure 1), the information dissemination server (IDS) collects and evaluates information available in databases from national and theater sources and disseminates this information to the deployed warfighter within a tactical theater of operations. When the information available matches a warfighter's need posted via the **reachback link**, the IDS sends the information via the **return link** to a **GBS uplink** earth station for transmission to a satellite. The satellite broadcasts the information to the warfighter's downlink GBS receiver

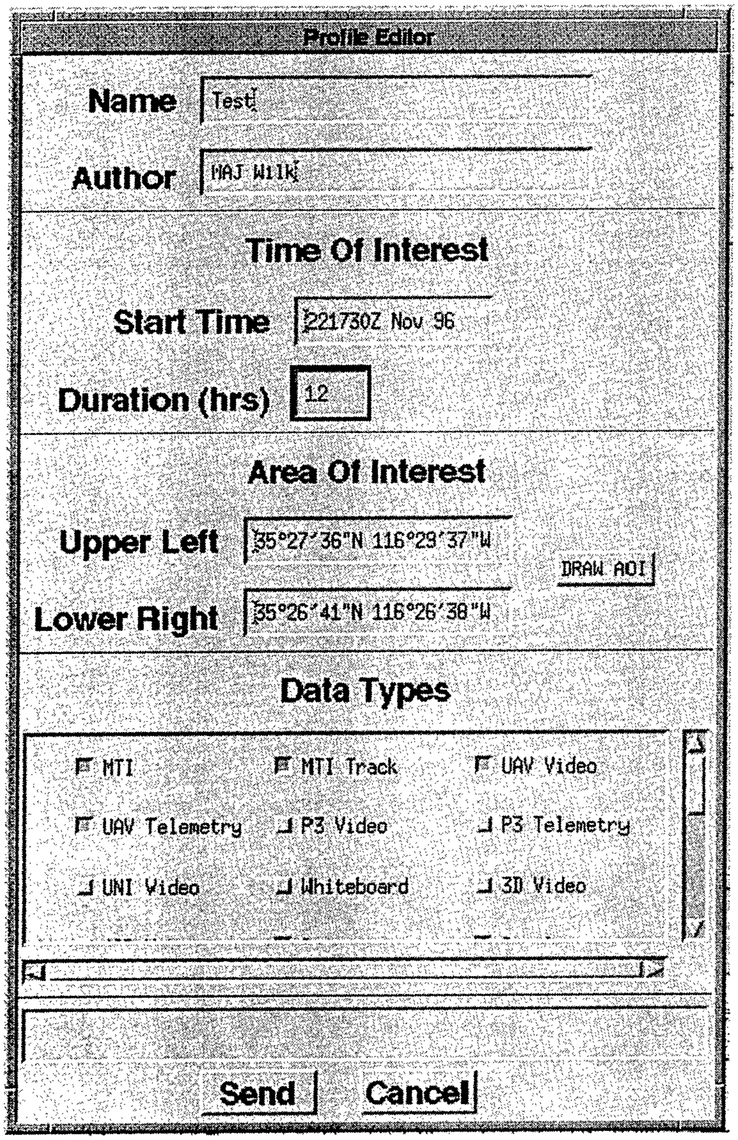

Figure 2.
Profile editor.

at the remote site.

At the receiving station, the broadcast data are deposited into a workstation local to the warfighter referred to as a Warfighter Associate **(WFA)**. The WFA, among other functions, **replicates** the databases from which the information was drawn and functions as a **local server**. The data are then available to other **user workstations** via Tactical Operations Center (TOC) local area networks (LANs). The concept is for one receiving station, along with a server, to provide information for each LAN (in this case, each TOC). Types of information disseminated over GBS/BADD include data, imagery, maps, intelligence overlays, real-time video, weather, logistics data, and battlespace status in any combination of video, voice, and data (full multimedia presentation). The warfighter uses the existing military communication systems, including the Continental United States infrastructure and the tactical communications network, to transmit information requirements to the IDS. This reachback communication is restricted to very concise instructions, thus reducing the data flow on the tactical communication network.

Information Management

Information management (IM) is emerging as a key technology requirement for managing huge volumes of multimedia data on the future battlefield. With IM tools, the commander can define mission data for the appropriate geographical, temporal and data type requirements.

The principal function of IM is to match available data with the warfighter's needs without manually searching for these data. This allows the warfighter to focus on tasks central to the mission. Another benefit is that superfluous information is filtered out, permitting the warfighter to focus only on critical data.

A "smart push" of information refers to delivery of data that match a "profile" (see Figure 2) registered by the warfighter. In the BADD Phase I context, the warfighter submitted a profile by filling in a form on a displayed software window. The profile specified the overall data requirements for a present or future mission. This managed the information flow appearing in databases, i.e., present and future data. To obtain data not already locally available, a "warfighter pull" of information permits the warfighter to request specific data from the network. In the BADD Phase I context, the "query" command accomplished this and was used to request historical data.

Accomplishments

The Task Force XXI AWE was a very important benchmark for the Army's effort to digitize the battlefield. The accomplishments of the GBS/BADD Program were instrumental in developing an understanding of the merits and issues associated with employing IM and wideband dissemination at tactical echelons. GBS/BADD provided the maneuver battalions with unprecedented access to information that proved critical to their success in executing their missions. The maneuver battalions considered GBS/BADD a major provider of information at this echelon. Most important to the commander was moving target indicator (MTI) radar data, which allowed the enemy to be seen in motion with precise location and movement information. The battle staff also found unmanned aerial vehicle (UAV) video dissemination to the battalion TOCs very valuable. A brief summary of the major accomplishments follows.

A low-cost broadcast capability via GBS was combined with an IM system. Leveraging the low-cost consumer direct-to-home entertainment system, real-time video and encrypted wideband data were demonstrated with an IM system, which made the massive amounts of information available to the warfighter more intelligible and relevant to the mission.

A tactical repository for UAV imagery with time and space attributes was developed using metadata. Using a common ground station/prototype

(CGS/P) receive workstation, a UAV provided battlefield video clips that were passed to the local TOC server, the WFA. The video clips were stored in a database at the remote IDS, and the frames were passed to the requesting client. The UAV flightpath and field-of-view polygons were displayed on the map background and correlated with video clips captured from the analog video from the camera. The warfighter could be very precise in selecting exactly the view to be analyzed. The UAV and MTI data were disseminated in near real time, subject only to minor processing delays associated with creating the database files and the GBS communications link propagation delay.

Storage, retrieval, and dissemination of data were provided. The BADD IDS and WFA provided the means to store, retrieve and disseminate data received from various information sources including the UAV video, battlefield video teleconference (BVTC), Integrated Meteorological System (IMETS) weather data, and All Source Analysis System intelligence data throughout the battlefield.

A correlated view of the battlespace was displayed. The BADD WFA, through its links to other Army Battle Command System workstations, displayed a correlated view of the battlespace. The red/blue force situation awareness display was overlaid with UAV video from the CGS/P and MTI data from the Joint Surveillance Target Attack Radar System (JSTARS) downlink to the CGS/P.

Additional capabilities such as one-way BVTC and collaborative (whiteboard) planning for communicating the commander's intent, and broadcast of IMETS weather data via a proxy home page further enhanced battlefield awareness.

Available data were matched with warfighter needs. Based on settings of profiles and queries, the warfighters' needs for information were established. From these inquiries, the local TOC server (WFA) and the IDS (along with the associated databases and repositories) serviced these requests. The ability to set display filters to show only the data needed based on the three attributes of space, time and data type was demonstrated. This capability reduced display clutter and information overload of the warfighter.

Lessons Learned

The need for expanding the existing communications bandwidth by 100 to 1,000 times for multimedia information delivery at echelons down to the maneuver battalion has proven to be essential for the battlefield of the future. IDM will enable a multimedia capability for the warfighter. There is a need for more extensive access to multimedia battlefield products including near real-time video, imagery and other sensor products, and access to large databases.

The Army learned from executing the AWEs that in-theater injection is mandatory. Connecting in-theater data sources to a commercial communication infrastructure, thus moving data 6,000 kilometers to a remote broadcast uplink to get it to the user 150 kilometers from the data sources, is unnecessarily cumbersome. IDM will be essential to the success of the fielding of GBS, and to developing the First Digitized Force as GBS is made an extension of the Defense Integrated Services Network infrastructure.

Data source locations on the battlefield can be diverse. This presents the challenge, not yet addressed, of transporting the data from the source to the GBS injection site. For instance, the CGS was located at the brigade level in TF XXI, whereas the Theater Injection Point terminal is expected to be a joint asset at the corps level for a joint task force.

There is still a need to develop tactical repositories containing the source information derived within the theater of operations. It must be made clear that in executing the Phase I ACTD, a tactical repository was manufactured to enable the demonstrations. The BADD ACTD was not intended to be a repository project. Rather, BADD searches all available information sources, whether in theater or at the national level, and matches the information with warfighter needs. For the immediate future, the CGS data, the dissemination of which was central to the operational success of BADD Phase I, cannot be used to digitize and store the information, and be disseminated and viewed in accordance with a commonly accepted scheme.

The GBS/BADD capability should be incorporated into the digital design as a "user owned and operated" capability, where the IM services are embedded into the operating environment of existing workstations, and other applications are available for integration into battlefield functional areas that require those capabilities. The need for a TOC warfighter information server has long been speculated, and is described in the Warfighter Information Network Master Plan, which can be accessed at **http://www.sysarch.gordon.army.mil**. Ownership, implementation and location of this server function is debatable, and requires more extensive consideration to allow a rational approach for integrating IDM into the future battlefield digital architecture.

Conclusion

The GBS/BADD Phase I ACTD resulted in fielding a rapid prototype capability that demonstrated the value of multimedia information delivery into TOCs at brigade and battalion levels, and the intelligent presentation of that data to the warfighter. Information dissemination management technology is the key enabler to provide this capability. A strategy needs to be implemented very soon that results in an Operational Requirements Document and Program Objective Memorandum to fund the integration of information dissemination management into the digitized Army. BADD has the potential to be a great asset on the battlefield, with proper coordination and planning. A question remains whether this capability will be implemented in time for the first digitized force in September 2000.

More information on the BADD, references, and related materials are accessible via the World Wide Web at **http://www.monmouth.army.mil/cecom/rdec/isio/isio.htm**.

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Leading The Pack . . .

RAPID ACQUISITION AT THE ARMY SPACE PROGRAM OFFICE

MAJ Steven Lopez and Sharon Carvalho

Introduction

The Department of Defense (DOD) is looking for new ways to do business more efficiently and still maintain high states of readiness and high levels of support to field forces. In a statement before the House Committee on National Security last year, Dr. Paul Kaminski, then Under Secretary of Defense (Acquisition and Technology), laid out the reasons for necessary changes when he stated, "The DOD cannot afford a 15-year acquisition cycle time when the comparable commercial turnover is every 3 to 4 years ... the military advantage goes to the nation that has the best cycle time to capture technologies that are commercially available, incorporate them in weapon systems, and get them fielded first." The Department of the Army took up this very challenge a quarter of a century ago at a time when many of the accepted business practices in DOD were slow and cumbersome.

Army Space Program Office

A team led by Dr. Richard Haley, then Chief Scientist of the Army, sought to speed up the process and accelerate the pace at which systems are fielded to the tactical commander. Frustrated with the acquisition practices of the early 1970s, this team came up with a concept for an organization that would provide intelligence information to the tactical commander by integrating Army systems to coincide with the development of new space systems and theater reconnaissance systems. Armed with a charter to provide direct, swift and progressive support, the Army Space Program Office (ASPO) was established in 1973. It was authorized to exploit current and future national and tactical sensors for insertion into the Army's tactical decisionmaking process as rapidly as possible, operating under a waiver to the standard acquisition model from the Chief of Staff of the Army. Today, ASPO is part of the Space and Missile Defense Command (SMDC) and serves as a member of the SMDC Acquisition Center.

In Army parlance, ASPO was dubbed Army TENCAP—Tactical Exploitation of National Capabilities. During the last 25 years, it has fielded close to 60 systems of various sizes, missions, and complexity using rapid acquisition techniques. TENCAP systems consist of ground stations, intelligence data processors, and communications systems that receive, process, and disseminate intelligence data from national systems in support of tactical operations.

The Army TENCAP Program

The scope of the TENCAP Program embraces all phases of materiel development, system acquisition, and sustainment. ASPO provides a system of "cradle-to-grave" logistics support through a combined effort of government and contractor personnel and facilities. New systems are developed under the direction of a Department of the Army General Officer Steering Group that is co-chaired by the Deputy Chief of Staff for Operations and Plans and the Assistant Secretary of the Army for Research, Development and Acquisition.

ASPO's unique approach has demonstrated an impressive record of rapid integration. As the program office grew from its original staff of two soldiers and three civilians to an organization today of more than 40 military and civilian employees, it shaved years off the standard 15-year acquisition timeframe, typically fielding a system in 2 to 4 years. Key factors for success include an environment emphasizing stable funding and low-density acquisition, maximum use of commercial technology, minimal use of military specifications, and managed competition. By tailoring existing technology, leveraging the best commercial practices, and using commercial off-the-shelf (COTS) and government off-the-shelf hardware and software, ASPO minimizes risk while maximizing efficiency. Strong user involvement and a robust operations and maintenance program in a vigorous preplanned product improvement (P3I) environment help ensure programmatic success.

Key Factors For Success

ASPO's acquisition strategies are modeled after sound business practices. In starting a new system, ASPO teams with the user and maintains a partnership with industry. Cost as an independent variable is a major consideration. Rapid acquisition permits ASPO to keep pace with technology and industry, while technical risks are addressed early. ASPO fields the system as a prototype to ensure user involvement and evolves the system in response to continuous user feedback within the context of the P3I plan. Most important, ASPO oversees the system throughout its life cycle, securing a high degree of visibility of each system. This visibility enables the organization to plan for the entire life cycle: from concept to design, test and evaluation; fielding; and then into the sustainment phase. This approach also ensures a long-term commitment and high quality of continuity vital to total life cycle success.

Projects maintain high visibility throughout the entire life cycle, not simply one or two phases. The organization initiates development and establishes a baseline requirement and design upfront for P3I. This ensures sustainability and maintainability of each system. Project officers are empowered to make decisions and take personal responsibility, thereby becoming stakeholders in the program.

The ETRAC Program

A prime example of ASPO's successful method of rapid acquisition is the Enhanced Tactical Radar Correlator (ETRAC) System. ETRAC was developed by ASPO to provide Army field commanders with accurate, reliable, and timely image-based battlefield intelligence derived from the all-weather, high-resolution, Advanced Synthetic Aperture Radar System-2 (ASARS-2) radar sensor carried onboard the U-2 aircraft. To accomplish its mission, the ETRAC provides direct receipt of ASARS-2 data, near real-time processing of ASAR-2 data into digital images, soft-copy display of the images, limited exploitation of images into intelligence products, and ensured dissemination of products to the user.

ETRAC capabilities include comprehensive mission planning and robust communications. To perform its mission in a worldwide tactical environment, the ETRAC is air transportable by no more than two C-130E aircraft, requires no special loading/unloading equipment, has its own integral electrical power source, and is self-sufficient for at least 14 days.

There are two ETRAC systems in the inventory. ETRAC 1 is positioned at Fort Bragg, NC, ready to deploy as part of the 18th Airborne Corps early force projection package. ETRAC 2 is assigned to the V Corps and is currently operating in Tazar, Hungary, in support of Operation Joint Endeavor in Bosnia.

Comparison Of Key Concepts

DOD is implementing a number of programs designed to improve the scope of acquisition reform. ASPO methodology predates and parallels many of the methods DOD recently adopted or is considering adopting. The ETRAC program provides a case study of ASPO's rapid acquisition methods. Brief descriptions of these follow:

Contract Support Logistics. DOD advocates greater use of contract support logistics to minimize life cycle cost. ASPO supports a system throughout its life and has found contractor support as the most efficient and effective method. ASPO supports ETRAC with contractor-provided, onsite field service representatives for hardware and software maintenance. A contractor-operated Operational Support Facility (OSF) serves as an ETRAC maintenance facility. The OSF is used to recreate hardware or software anomalies in the laboratory, develop a fix, and send the updated software back to the field.

Open System Architecture. DOD supports adopting open system architectures that specify form, fit and function rather than exact design specifications. ASPO has used this method for years and incorporates open architecture into its contracts. ETRAC was designed with an open architecture for built-in growth, using industry standard UNIX software. To acquire the supercomputer power required for real-time ASAR-2 image processing, ASPO used market-driven technology insertion, eliminating the need for separate processor development and allowing the system to be fielded with state-of-the-art technology. All of the hardware for the ETRAC's prime mission equipment, except the input/output unit, is COTS.

Real-Time Logistics. DOD is moving away from just-in-case systems toward commercial sector just-in-time systems. ASPO visited this issue years ago and provides an effective "one-stop" logistics shop for its customers, ensuring constant communication and easy access by providing a toll-free telephone number. Materiel is distributed when required, reducing the need to store spare parts and minimizing response and delivery times. ASPO has contracted out responsibility for maintaining an ETRAC depot, to include spares management, stocking, repairs, and shipping. Vendor service contracts are used extensively for COTS components and are very cost effective.

Direct Vendor Delivery. The DOD Direct Vendor Delivery Program provides for speedy and direct delivery to the customer, bypassing the government's warehousing and distribution. ASPO supports its systems through fast freight delivery of items. The support contractor is responsible for shipping of spares and other items to the ETRAC sites. The contractor has successfully used a variety of commercial shipping sources to achieve rapid turnaround of spare parts and equipment, and has done this on a worldwide basis.

Customer Interaction. A hallmark of ASPO's success is a continuous relationship with the user. ASPO fields systems using an "80-percent solution," which is a user-based concept and process that leverages customer input before, during and after the design phase and relies on close contact with the user to refine system capabilities. Once systems are fielded, the user plays a key role in the sustainment process by maintaining an active dialog with the project officer. Additionally, the organization sponsors biannual user conferences where system users, key management players, and project officers gather to share information and ideas or resolve problems.

In the case of ETRAC, using the 80-percent solution concept allowed the baseline system to be fielded in May 1995, only 36 months after contract award. ASPO then worked closely with the operating commands to develop a prioritized list of P3I requirements. A Block I upgrade with numerous system enhancements was completed in early 1997, and a Block II upgrade effort currently underway is scheduled for completion in 1998.

Partnerships. Various national- and Service-level agencies and organizations assist ASPO in executing its chartered responsibilities. Key to current and future Army TENCAP activities is developing and maintaining partnerships with other Service TENCAP organizations and industry segments. A host of organizations including operational commands, DOD, national agencies, other Army and sister Service development centers, laboratories, and contractor representatives are partners with ASPO in accomplishing its mission.

Conclusion

Some of the lessons learned by the Army Special Program Office have been incorporated into the mainstream Army acquisition process, but clearly there are many other lessons the ASPO has learned that are applicable for further acquisition streamlining for the Army as a whole. The Army cannot afford to lock in on the status quo; it must be bold and take calculated risks if it hopes to accelerate the pace at which systems are fielded.

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TARDEC'S SIMULATION-BASED VEHICLE ACQUISITION AND SUPPORT CAPABILITIES

David D. Gunter and
Michael D. Letherwood

State-of-the-art high-performance computing facilities allow the integration of virtual prototyping and dynamic modeling expertise into a complete wheeled- and tracked-vehicle system simulation capability.

Introduction

To support Department of Defense-mandated acquisition reform initiatives, the Tank-Automotive Research, Development and Engineering Center (TARDEC) Virtual Prototyping Group is using simulation-based acquisition strategies to investigate the dynamic performance of ground vehicles throughout the vehicle development, testing, and fielding life cycle process. State-of-the-art high-performance computing (HPC) facilities allow the integration of virtual prototyping and dynamic modeling expertise into a complete wheeled- and tracked-vehicle system simulation capability. These facilities routinely provide modeling and simulation (M&S) support to program executive officers, program managers (PMs), industry, academia, and other research and development centers, to evaluate the stability, handling, and ride quality performance of virtually all types of wheeled- and tracked-vehicle systems.

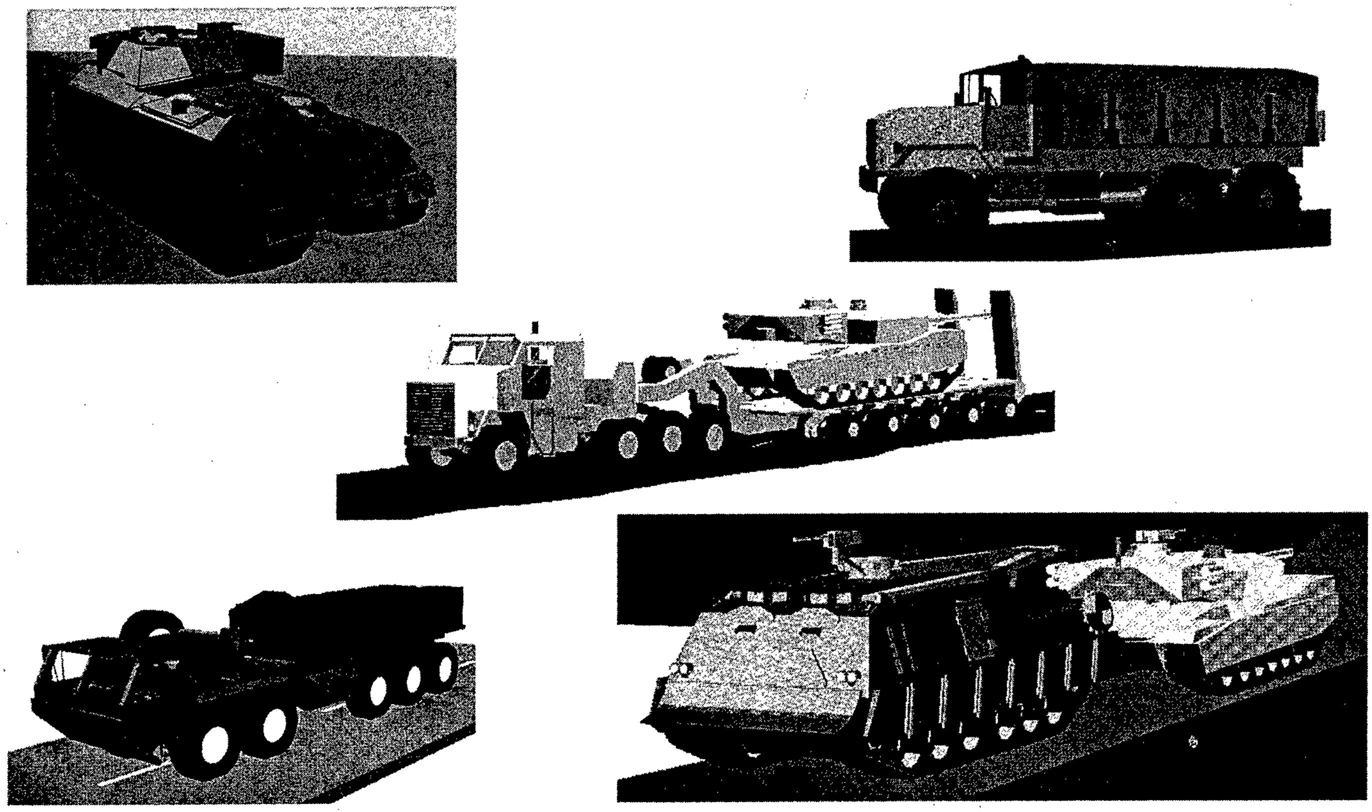
TARDEC is effectively using M&S to evaluate new designs prior to selection and testing; support operational and developmental testing; evaluate field mishaps and/or accident situations; and investigate configuration management changes, product improvement programs, and alternative payloads.

Background

TARDEC recognized the need for high-resolution military vehicle system M&S methodologies in the mid-70s, but at that time, none existed. In 1978, the organization now known as TARDEC funded research at the University of Iowa to begin work on a general computer-based methodology that would provide a framework to assemble models of broad categories of mechanical systems. That research program resulted in a modeling methodology called Dynamic Analysis and Design System, or DADS, to address military vehicle design and analysis problems. This led to continuing TARDEC support to the University of Iowa in development of a more advanced methodology in support of vehicle programs. Since then, TARDEC has greatly expanded its military vehicle M&S capability.

Analytical support to program executive officers, PMs, and weapon system managers has more than doubled every year since 1982, and support requirements exceed manpower. One of TARDEC's mission areas is to provide analytical support through computer-based vehicle system modeling, simulation, and post analysis. TARDEC personnel have gained considerable experience with the military vehicle

Simulation-Based Vehicle Acquisition and Engineering Support



Clockwise, from upper left, Bradley M2 Infantry/M3 Cavalry Fighting Vehicle; Marine Corps Advanced Technology Testbed Demonstrator; Hercules Recovery Vehicle towing an M1A2 Tank; Palletized Load System Truck; and center, Heavy Equipment Transporter System transporting the M1A2 Abrams Tank.

environment, having defined, developed and validated numerous vehicle system models since 1978. Modeling and simulation of off-road vehicle system performance has been the most challenging task to date because of highly nonlinear response characteristics such as vehicle rollover, severe tire and suspension deflections, and soil deformations. TARDEC engineers have also worked with the University of Iowa to develop a reliability forecasting method for predicting the life of critical vehicle mechanical components.

Customer Focus

TARDEC continues to respond to the Army's growing need for high-resolution, computer-based vehicle models to quantify dynamic performance specifications and upper bounds on safe operating performance envelopes. For example, high-resolution models of the Heavy Equipment Transporter System were constructed during initial source selection activities and have been used where feasible throughout the development life cycle of the tractor/semitrailer combination. Validated vehicle model predictions have been applied to rapidly answer many technical evaluation, design and product improvement questions. Answering these questions through field or laboratory tests is too expensive or dangerous.

TARDEC aggressively seeks out customer vehicle design and evaluation projects and continually interacts with procurement specialists, source selection evaluation boards, PMs, and program executive officers to identify their analysis needs and provide quick solutions to them. Engineers define the specialized subsystem models—unique to each vehicle—that are necessary to achieve adequate model resolution and accuracy. These subsystem models are also used to ensure correct development and validation. Time constraints and aggressive procurement schedules are all too common in today's acquisition environment. In response to these challenges, TARDEC uses HPC to make the Army a smarter and more cost-effective buyer of equipment, and reduce the risks inherent in procuring newly designed, untested equipment.

Case Studies

Recently, during source selection

activities on the Army and Marine Corps Medium Tactical Truck Remanufacture Program, TARDEC used high-resolution, computer-based models to assist in assessing and evaluating the performance of new vehicle designs submitted in response to a formal solicitation. Prior to the source selection process, TARDEC used M&S to establish and define desired performance and handling characteristics. Representative models of each bidder's concepts were developed based on contractor-supplied data, and then used to evaluate the performance of the newly designed systems to ensure compliance with request-for-proposal-mandated performance requirements. Because of much-increased HPC computational speeds, memory, and asset availability, entire spectrums of operational mission scenarios were investigated. This allowed the evaluation of capabilities such as steering stability and handling, turning, off-road ride quality, tilt-table, and side slope stability necessary to meet mission requirements.

Recent major upgrades in TARDEC's HPC facilities now allow the highly detailed, computationally intensive models to be run in a fraction of the time. Even more important are the increased number of "what if" studies that can now be performed. Hundreds of simulations can now be set up and run on a daily basis to investigate every aspect of vehicle design that might impact overall vehicle performance.

To support the Program Executive Office, Armored Systems Modernization (PEO-ASM), TARDEC developed high-resolution models of an improved recovery vehicle towing an M1 Tank, intended primarily to evaluate various towbar designs and external braking mechanisms. TARDEC engineers applied models to assess traction devices designed to enhance pulling and braking capabilities. PEO-ASM used the data to augment field tests and facilitate vehicle modifications.

The major driving force behind high-resolution, computational dynamics is cost effectiveness. Low-cost, high-performance computers and powerful software are making real-time, high-resolution vehicle system simulations a reality. Representative model predictions can complement and/or replace costly or dangerous field and laboratory tests.

Effective use of dynamic simulation requires accurate representation of vehicle systems; conversion of data into validated, high-resolution computer-based models; and application to many diverse problems. More stringent performance specifications are also being placed on vehicles to meet changing battlefield requirements and varying mission scenarios.

Another effort was recently initiated to develop and evaluate concepts to explore alternative uses for the Palletized Load System (PLS). Alternative uses of the PLS include transportation of volume water and fuel, as well as specialized combat engineer missions. TARDEC used M&S to evaluate the stability and handling characteristics of the PLS Truck/Trailer (PLST) combination while transporting newly designed PLS variant payloads.

Analytical models can be further employed to assist TARDEC engineers in assessing the feasibility of towing trailing units behind various prime movers. Virtual assessments of a prime mover/trailing unit's stability and handling characteristics and overall system performance can be investigated prior to field testing and implementation. Vehicle models can be upgraded as dictated by product improvements, configuration management changes, and varying payload configurations. As a result, the models are useful throughout the life cycle, and are subsequently used to help establish performance requirements for replacement vehicles.

In another recent effort to support fielded vehicle systems, TARDEC engineers were asked to develop and validate models of the M939 series 5-ton truck towing an M198, medium 155 mm howitzer. The purpose was to investigate truck/howitzer dynamic stability while negotiating specially designed on-road braking maneuvers over a range of vehicle speeds. The follow-on analysis was also intended to determine the influence of an 8-ton-plus howitzer on the stability of the truck during braking maneuvers when the truck is operating in an unloaded condition.

Applying acquisition reform principles, vehicle developers are using M&S on new vehicle system programs wherever possible to save time and costs. Wheeled- and tracked-vehicle systems must be capable of operating on the virtual proving ground and in synthetic environments for testing, training, design and troubleshooting evaluations. Computer-generated forces are becoming increasingly important in distributed battlefield simulation, and representation of their behavior has gained commensurate interest as a research topic. Drawing on simulation, limited field testing and vehicle characterization, TARDEC engineers are attempting to reproduce ground vehicle behavior that is both autonomous and more realistic.

Conclusion

The major performance areas that benefit from high-resolution vehicle simulations are mobility, stability, reliability and safety. Ground vehicles must be capable of operating in very harsh environments. As such, vehicle developers are responsible for setting realistic performance specifications and ensuring that they are met. M&S is making the Army a smarter and more cost-effective buyer and tester of vehicles and equipment and, more importantly, significantly reducing risks to personnel and property that are inherent in a warfighting environment. In addition, M&S can alleviate and/or avoid the endless build-test-break-fix cycles that were common in many previous vehicle acquisition and testing programs, thereby reducing costs and shortening milestone schedules. Although it is difficult to quantify overall life cycle impacts of doing it right the first time, M&S has proven to be an excellent tool for decisionmakers, in response to time and budget constraints, as well as aggressive procurement schedules.

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MICHAEL D. LETHERWOOD is a Mechanical Engineer and Team Leader of the Analytical Simulation Team with TARDEC's Virtual Prototyping Group. He holds B.S. and M.S. degrees in engineering from the University of Michigan and Wayne State University, respectively, and is Level III certified in program management and systems planning, research, development and engineering career fields.

GROUND VEHICLE MOBILITY TECHNOLOGY: ELECTROMECHANICAL SUSPENSION

Wesley W. Bylsma

Introduction

Research and development (R&D) of state-of-the-art technology is necessary for continued success of military operations. Technology plays a greater role in combat situations than ever before. With this in mind, the Research Business Group of the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) in Warren, MI, continues to research and develop vehicle suspension systems.

Mobility is significantly impacted by a vehicle's suspension. Active suspension systems provide superior ride and handling performance, which impacts mobility. An electromechanical suspension is one example of a technology development that can improve mobility.

Although mobility is a simple concept, it encompasses more than just keeping a vehicle in motion. The rate at which the motion of a vehicle can be sustained is of equal importance. For example, an insufficient rate of motion will prevent a vehicle from reaching a zone of safety or, for offensive purposes, providing a first-strike advantage.

The relationship between vehicle dynamics and mobility is also important in understanding the impact that a suspension system has on a vehicle's mobility. Vehicle dynamics encompass ride quality and handling, both critical factors affecting mobility. A vehicle's suspension system greatly influences these factors. The suspension system and vehicle-terrain interface are both part of the vehicle dynamics control loop.

The suspension is located between the sprung and unsprung mass. The sprung mass is all vehicle parts supported by the suspension. The unsprung mass is the roadwheel assembly not supported by the suspension. The forward motion of a vehicle over a terrain causes accelerations of the unsprung mass. The terrain interface (the point of interaction between the ground and the vehicle, e.g., compliant tires or track) filters these accelerations, lessening their impact, before reaching the unsprung mass. The driver, seated on the sprung mass, experiences the same accelerations, and adjusts the vehicle's velocity to bring the accelerations to a suitable tolerance rate.

The suspension filters the accelerations between the sprung and unsprung mass. Since the driver acts as the controller in this loop, the purpose of the suspension is to provide the best isolation possible. If done successfully,

Mobility is significantly impacted by a vehicle's suspension. Active suspension systems provide superior ride and handling performance, which impacts mobility.

the driver is able to maintain high rates of velocity without discomfort, thus eliminating the need to reduce velocity (i.e., slow down). The electromechanical suspension is one technological approach to achieve this benefit of active suspension with advantages over other implementations.

Suspension Types

Historically, three types of suspensions have been used: passive, semiactive and active. Active suspensions are the newest and most advanced.

Passive suspensions consist solely of passive components: a spring for energy absorption and a damper for energy dissipation. The rate of energy absorption and energy dissipation are fixed.

Semiactive suspensions are the same as passive suspensions with the exception of variable damping capabilities. Semiactive suspensions can vary the rate at which energy is dissipated, and they offer a compromise between active and passive suspensions: lower cost, negligible demand for power, and comparable performance to active suspensions when forces are mainly dissipative.

Active suspensions consist of a spring for energy absorption and a force actuator that can cancel or input energy into the system. Energy can be input or taken out as desired, limited only by the power supply. Active suspensions offer more versatility in managing energy flow, but at a price. Although active suspensions overcome many of the limitations of passive systems, they are more expensive because of the sensors, force actuator, and control mechanism they require. Because of their complexity, active suspensions tend not to be as reliable as passive systems. Despite this, however, they offer the greatest promise for improved mobility. Thus, current R&D efforts are directed at overcoming their reliability problem.

Early Developments

Lotus Engineering of England first became involved with active suspensions because of its work with the race car industry. To compensate for the aerodynamic down forces pushing race cars too close to the ground, Lotus developed a hydraulic active suspension. The goal was to maintain a minimum distance above the racetrack. In 1987, Lotus obtained a patent on this invention. Interestingly enough, this is the same time Ford Motor Co. began development of an electromechanical active suspension. In 1991, Ford obtained a patent but ended further development in 1995 because of the belief that customers would not pay the extra $5,000 for the feature. In mid-1989, Nissan introduced the Infiniti Q45a, currently the only production vehicle with hydraulic active suspension.

Recent Army Efforts

The Army's recent efforts in active suspension research began in 1992 in conjunction with Lotus Engineering. Attempts to develop a hydraulic active suspension for the High Mobility Multipurpose Wheeled Vehicle (HMMWV) culminated in 1994 with tests at Waterways Experiment Station.

Because of interest in electromechanical active suspensions, TARDEC and the University of Texas-Center for Electromechanics (UT-CEM) began development of a proof-of-principle electromechanical rotary actuator to replace the M1 Abrams rotary trailing-arm suspension unit. This effort led to the conclusion that linear technology was necessary to provide an appropriate force-to-weight ratio.

During 1996 and into 1997, TARDEC conducted research with UT-CEM to develop a linear actuator. Demonstration and testing of the actuator in an electromechanical suspension integrated into a hybrid-electric HMMWV is also an important step in the development of this technology.

Development of the actuator began by looking at the actuator forces required for various ride and handling conditions. After surveying off-the-shelf technology, UT-CEM determined that currently available actuators would not meet the force, weight, or space requirements. A more complete actuator was needed. Using off-the-shelf permanent-magnet, direct current motor rotor and stator components, in combination with a geared system for superior mechanical advantage, UT-CEM designed a custom case to enclose and mount the motor to the geared system, including a rack and pinion. The rack and pinion converts the torque gained through the geared system into a linear force.

The permanent-magnet motor provides more force capability than a wound motor and also reduces the actuator weight. The geared system (3.33-1 ratio) allows the motor to rotate at about 1,530 revolutions per minute (rpm) with a peak force of 2,000 pounds. The average power required to operate it is about 1 horsepower.

Performance

Previous results from the proof-of-principle M1 Tank electromechanical rotary actuator simulation and lab tests showed a 6-times reduction in hull (sprung mass) accelerations compared to those of a passive system. Over a 3.486-inch root-mean-square (RMS) course, this gives a ride-limiting speed (6-watt absorbed power) of 40 mph compared to 10 mph for the passive system. Test results show vibration isolation capabilities for this actuator provide a 7-times reduction between sprung and unsprung accelerations over a 1.12-inch RMS terrain.

Initial static testing indicated ambient air cooling would be sufficient for operating conditions. Additional dynamic testing showed significant heat generation and the need for liquid cooling to maintain force and temperature requirements.

Conclusion

Preliminary tests show the actuator provides significant vibration isolation capabilities. These results were not from full-performance tests. The terrain inputs were relatively mild, and one should be cautious in projecting vehicle performance based solely on actuator tests. However, the actuator results indicate a good chance of achieving a 100-percent increase in cross-country speed. The objective of the next phase in the development process is to integrate these electromechanical linear actuators into a suspension on a hybrid-electric HMMWV for demonstration and testing to see actual performance gains of a full electromechanical active suspension system. The demonstration and test will be completed during the next 2 years.

WESLEY W. BYLSMA is an Electrical Engineer at TARDEC. He has an M.S. degree in electrical engineering from Oakland University.

USING MINIATURE-SCALE HIGH-EXPLOSION EXPERIMENTS TO STUDY WEAPON EFFECTS

Dr. C.R. Welch,
C.E. Joachim, and
Dr. W.F. Marcuson III

Introduction

Recently, the U.S. Army Engineer Waterways Experiment Station (WES) began a program to develop methods that will allow battlefield explosion effects to be replicated at "miniature-scale." Miniature-scale explosion experiments use a few tens of grams of explosives and are performed, figuratively, "on a desktop." They can replicate and replace many large-scale explosion field experiments that use many kilograms of explosives. They make use of explosive sources that are on the order of tens of grams of TNT explosive equivalent or less, and typically have length scales relative to a prototype event of 1/10 to 1/1000. They are conducted over periods of days as opposed to the months required for large-scale experiments, and they cost tens of thousands of dollars as opposed to hundreds of thousands or millions of dollars. Similitude theory is used in the design of miniature-scale experiments and in the interpretation of their results. In many cases, miniature-scale experiments, in combination with numerical simulations and verifying field experiments, provide the most cost-effective and expeditious method to develop an understanding of explosion phenomena. This article describes the cratering experiments performed by WES and the potential impact of miniature-scale explosion experiments on future military research.

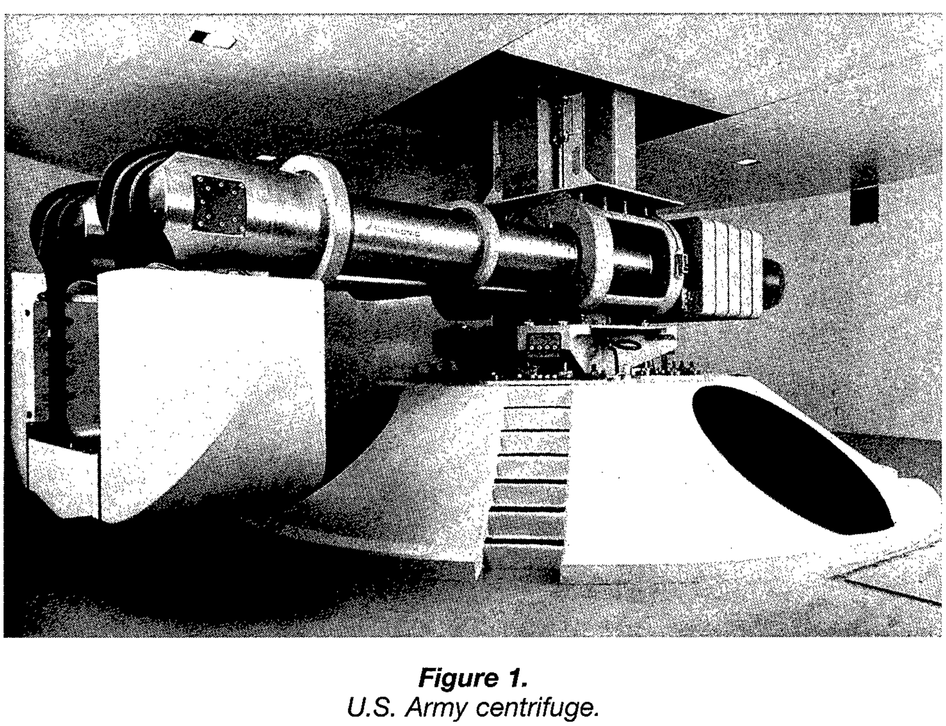


Figure 1.
U.S. Army centrifuge.

Background

High-explosion experiments are used for studying weapon effects and the response of structures to these effects. Historically, these have been large-scale experiments, using tens or hundreds of kilograms of explosives. The scale of an explosion experiment refers to the relationship between the experiment and the event it models, and usually refers to length scale. For example, a one-half-scale cratering experiment would produce a crater with one-half the diameter and one-half the depth of a prototype cratering event.

Numerical simulations can be used to reduce the number of large-scale explosion experiments necessary to predict the explosion-induced flow fields and their interaction with surrounding environments and structures. But numerical simulations cannot eliminate the need for experiments because of assumptions involved in numerical modeling. Thus, although there have been significant improvements in modeling explosion effects using numerical simulations, explosion experiments are necessary to verify these simulations.

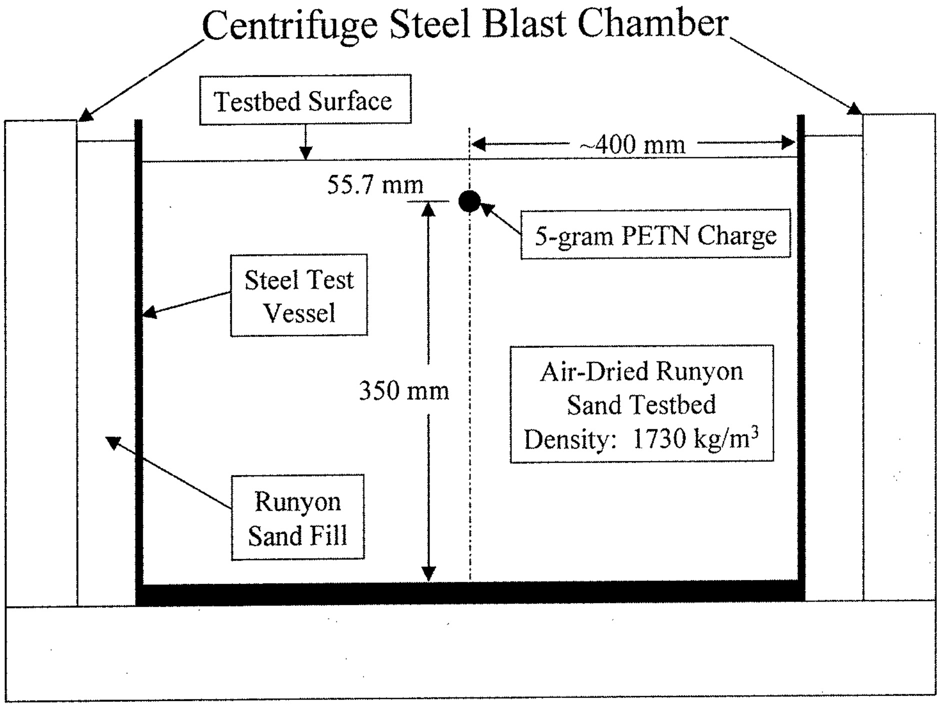


Figure 2.
Cross-sectional geometry for laboratory-scale experiment.

Miniature-scale explosion experiments have the potential to greatly reduce the time and money needed to predict the outcome of a wide variety of detonation scenarios.

The mechanics governing effects from explosions do not necessarily break down with significant changes in scale. Those instances in which the mechanics do not break down provide an opportunity to replace large-scale experiments with small-scale experiments.

Miniature-Scale Cratering Experiments

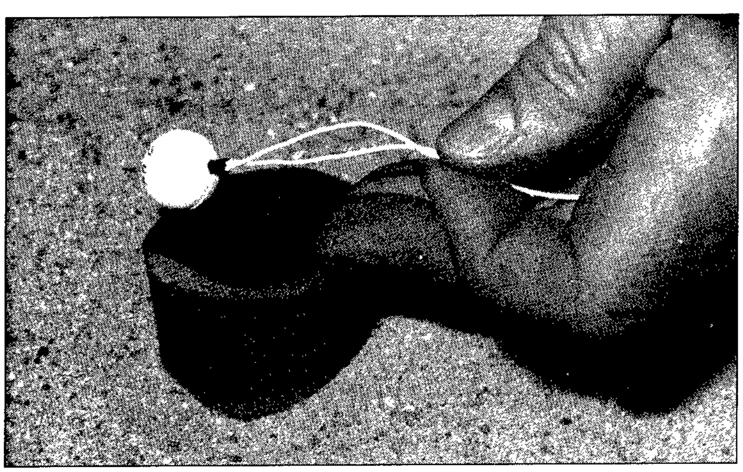
During the past few months, WES conducted three miniature-scale explosion experiments to model several phenomena, including cratering. The newly completed Army Centrifuge (Figure 1) was used to conduct these experiments. In particular, a large-scale cratering and ground-shock field experiment used a center-detonated, 454-kilogram nitromethane spherical explosive charge detonated at a 2.5-meter depth in a testbed of sand (Socorro plaster sand). Figure 2 shows a cross section of the geometry used in model crater experiments. The Army Centrifuge is the world's most powerful and allows geologic samples of up to 2,000 kilograms to be exposed to explosion effects while under gravitational fields of up to 350 Earth gravities. Cratering phenomena are long-term response phenomena and are significantly affected by the gravitational conditions under which the craters are formed.

The model testbeds were constructed from a local sand (Runyon Sand), which has gradation and mechanical properties similar to that used in the field experiment. The sand was air-dried, sieved, and then placed in a steel chamber with the same density as in the prototype event.

Figure 3 shows one of the precision 5-gram, center-detonated, PETN explosive charges being placed in a model testbed. The linear scale of the experiment was set by the cube-root of the ratio of the mass of the prototype explosive charge to the precision charge mass (See B. Hopkinson, British Ordnance Minutes, 13565, 1915). This resulted in the linear scale between prototype and model of 44.9.

Figure 4 displays the average crater profile from each of the three model experiments, scaled to the prototype event, along with the prototype crater profile. The model experiments showed good repeatability (precision), and they replicated the prototype crater with reasonable accuracy. The primary differences seen between the replica craters and the prototype crater are attributed to inaccuracies in the hand measurements of the small replica

Figure 3.
Precision 5-gram explosive charge.



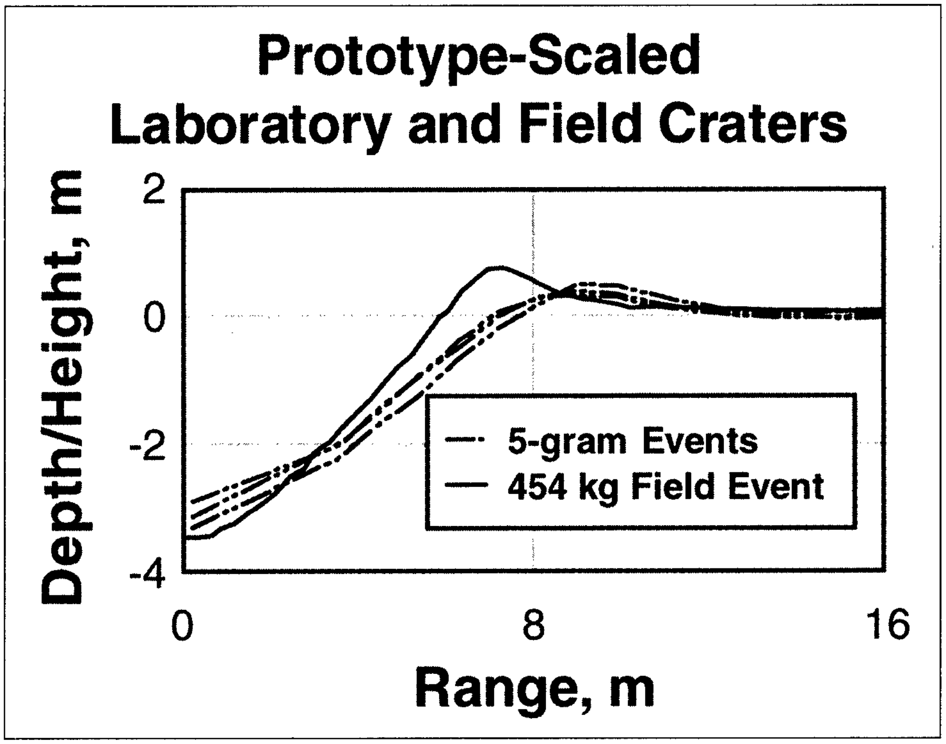


Figure 4.
Crater profiles from model and field events.

attributed to inaccuracies in the hand measurements of the small replica craters. A laser-based surface profiler currently being procured should reduce this problem.

The 454-kilogram prototype event included an extensive ground-motion array that was not included in the miniature-scale experiments. Had the prototype event not included the ground-motion array, it is estimated that it would have taken more than 1 month to conduct and would have cost more than $100,000. Each centrifuge experiment took less than 3 days to conduct and cost about $10,000.

Conclusion

Miniature-scale explosion experiments have the potential to greatly reduce the time and money needed to predict the outcome of a wide variety of detonation scenarios. While some large-scale experiments will be needed in the future, the number will likely decrease, and the purpose for many will be to verify what was determined via a combination of miniature-scale experiments and numerical simulations.

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CHARLES E. JOACHIM is a Research Civil Engineer in the Geomechanics and Explosion Effects Division, Structures Laboratory, U.S. Army Engineer Waterways Experiment Station. He has a B.S. degree from the University of Vermont and an M.S. degree from Mississippi State University, both in civil engineering. In addition, he is a licensed professional engineer in Mississippi and has authored or co-authored more than 60 technical publications.

DR. WILLIAM F. MARCUSON III is Director of the Geotechnical Laboratory at the U.S. Army Engineer Waterways Experiment Station. He has a B.S. in civil engineering from the Citadel, an M.S. in structures from Michigan State University, and a Ph.D. in soil mechanics from North Carolina State University. He has received numerous awards including the oldest and most prestigious American Society of Civil Engineers award, the Norman Medal, received in 1997. He is a member of the National Academy of Engineering and a member of the Senior Executive Service.

FROM THE ACMO DEPUTY DIRECTOR...

By the time you receive this issue, we will have welcomed COL Ed Cerutti as Director of the Acquisition Career Management Office (ACMO), and I will have resumed my duties as Deputy Director. We also bid a fond farewell to COL Bill Fast who, during his assignment with the ACMO, made outstanding contributions to the Army Acquisition Corps. He will assume command of the Defense Contract Management Command Springfield, Picatinny, NJ. His work will have a lasting impact on the Army Acquisition Workforce. We wish him the best in his new assignment.

I hope you benefited greatly from the information provided in the July-August 1998 issue of *Army RD&A* magazine. The issue was devoted to the Army Acquisition Corps (AAC), and the Army Acquisition Workforce (AAW), and the AAC vision to develop acquisition leaders for the 21st century.

Army RD&A magazine is just one of many sources available for obtaining information pertinent to your development as an acquisition professional. You should also have the AAC home page bookmarked as a favorite website to visit. It is not only the quickest way to find out current developments in acquisition career management, but is also an excellent source for historical information and links to related organizations. Our *Army Acquisition Workforce Newsletter* is a great way to find out what other professionals in the Acquisition Workforce are doing, and serves as a valuable resource to ask questions and provide input to other acquisition professionals and to the Acquisition Career Management Office. The newsletter can be found on our home page at **http://dacm.sarda.army.mil/publications/aaw/junjul98/**, and is also mailed to every member of the AAW.

I am encouraged by the level of response to our roadshow visits to the field. The AAW is getting better acquainted with the avenues available to further develop their acquisition careers. Our Mobile Acquisition Career Management Office team has received pertinent questions, and has enjoyed serving hundreds of Acquisition Workforce members with group briefings and one-on-one assistance. Be sure to participate when the roadshow comes to your area! The schedule can be found on our home page at **http://dacm.sarda.army.mil/news/awb.html**.

Congratulations to those selected for Acquisition Education, Training and Experience opportunities, listed on this page. Congratulations also to the recent graduates of the Materiel Acquisition Management Course at Fort Lee, VA. See Page 55 for additional information. Be sure to consult the article on Advanced Program Management Course Selection Criteria (Page 58) for helpful slating information, and the article on FY98 Lieutenant Colonel Promotion Board results.

Mary Thomas
Deputy Director
Acquisition Career
Management Office

Acquisition Education, Training And Experience Board Results

The Acquisition Career Management Office is pleased to announce results from the Acquisition Education, Training and Experience Board, which met June 25, 1998, to review applicants for training and educational opportunities. Congratulations to the following personnel selected by the board:

Name	Selected For	Location	Organization
Boedeker, Kathleen	Leadership Training	Duke University	PEO Aviation
Concilio, David	Leadership Training	Ctr. for Creative Leadership	CECOM
Edgar, Jim	Leadership Training	Columbia Business	SARDA
Flack, Marla	Leadership Training	Columbia Business	CECOM
Marcinkiewicz, Edmund	Leadership Training	Ctr. for Creative Leadership	CECOM
Mitchell, Mary Ann	Leadership Training	Ctr. for Creative Leadership	COE
Schwartz, Daniel	Leadership Training	Learning Tree International	CECOM
Vauter, Peter	Leadership Training	Ctr. for Creative Leadership	PM SADARM
Ahmad, Syed	School of Choice	Univ. of Alabama	AMCOM
Alexander, Todd	School of Choice	Univ. of Alabama	AMCOM
Busse, David	School of Choice	Univ. of Detroit	TACOM
Deckard, Richard	School of Choice	Florida Inst. of Tech.	CECOM
Dorman, Tyrus	School of Choice	Univ. of Texas	AMCOM
Eacret, Steven	School of Choice	Univ. of Alabama	SPACECOM
Edwards, Daphne	School of Choice	Florida Tech., AL	PM THAAD
Lucidi, Joseph	School of Choice	IC2 Institute	TEXCOM
McCoy, Mark	School of Choice	Oakland University	TACOM
Moore, Dale	School of Choice	Univ. of Alabama	PEO AMD
St. Jean, Dianne	School of Choice	Babson College	Natick Labs
Vale, David	School of Choice	Florida Inst. of Tech.	SPACECOM
Reese, William	UT-Austin Fellowship	Univ. of Texas	TACOM

AAW Roadshow Update

The Army Acquisition Workforce Roadshow continues, with visits to the U.S Army Forces Command in Atlanta, GA, and Rock Island Arsenal, IL, in July 1998, and a visit to TACOM, Warren, MI, in August 1998. All roadshows included a briefing by Keith Charles, the Army's Deputy Director for Acquisition Career Management, entitled "Making the AAC Vision a Reality." The Rock Island Arsenal and TACOM roadshows also included a session with supervisors, hosted by Charles, and an extended visit by the Mobile Acquisition Career Management Office (MACMO). The MACMO provided onsite information and assistance with acquisition career management issues. Leadership training seminars were conducted for the Corps Eligible population the week following the Rock Island Arsenal and TACOM roadshows. Corps Eligible members chose from two seminars: "Developing Leaders of Character," offered by the University of Texas at Austin, and "Career Architect," offered by the Workman Group, a private company.

Acquisition Education And Training Conference

The Acquisition Career Management Office (ACMO) and the U.S. Army Simulation, Training, and Instrumentation Command co-hosted an Acquisition Education and Training Conference Aug. 3-5, 1998, in Orlando, FL. Representatives from the ACMO, the U.S. Total Army Personnel Command, training representatives from the field, and Acquisition Workforce Support Specialists participated in the conference. Speakers included Keith Charles, the Army's Deputy Director for Acquisition Career Management, and Tom Crean, President of Defense Acquisition University (DAU). The conference included demonstrations of the automated Individual Development Plan, information about Acquisition Career Record Briefs, and information regarding online DAU course registration.

Acquisition Awards Management

A policy to streamline and consolidate the acquisition award process under the Acquisition Career Management Office (ACMO) was recently approved. The goal of the acquisition awards process is to foster achievement by recognizing excellence throughout the acquisition community. The ACMO is now the point of contact for several awards, including the David Packard Award for Excellence in Acquisition, the Project/Product Manager of the Year Award, the Defense Certificate of Recognition for Acquisition Innovation, and the Defense Acquisition Certificate of Achievement. More information on awards is available on the Army Acquisition Corps home page at **http://dacm.sarda.army.mil/awards**.

29 Graduate From MAM Course

Twenty-nine students graduated on June 5, 1998, from the Materiel Acquisition Management (MAM) Course, Class 98-003, at the U.S. Army Logistics Management College, Fort Lee, VA. The graduates included three foreign officers: CPT Jose Dayaday, an air force Supply Operations Officer from the Philippines; CPT Joze Rotar, an army Logistics Officer from Slovenia; and CPT Mahmud Hassan, an army officer from Bangladesh. The Distinguished Graduate Award was presented to CPT Kevin Vanyo, an armor officer en route to an acquisition assignment at Fort Knox, KY.

FY98 Lieutenant Colonel Promotion Board Results

The FY98 Lieutenant Colonel Promotion Board results were released in July 1998. The selection rate for Army Acquisition Corps (AAC) officers in the primary zone was 56.6 percent. This selection rate was below the Army competitive category average of 67.8 percent. The less than average selection percentage can be attributed to two factors. First, prior to the selection board, a significant percentage of successful officers were removed from the population through last year's rebranching board. Officers were selected to return to their basic branches based on their ability to successfully compete for promotion within their basic branch population. Nine officers were selected from the FY98 lieutenant colonel primary zone population. Of those, eight were selected for promotion. Adding these officers back into the AAC primary zone population results in an adjusted selection rate of 58.5 percent.

A second factor attributing to the less than average selection rate is that 11 officers within the FY98 lieutenant colonel primary zone population did not complete the Army Command and General Staff College (CGSC). The selection board did not view these officers as competitive for selection regardless of past performance. Removing these officers from the primary zone population results in a more accurate reflection of the promotion percentage of fully competitive officers. After this adjustment, the selection rate for AAC officers within the primary zone is 62.8 percent.

The primary zone selection percentage for AAC officers does not correlate to substandard performance by year group (YG)82 AAC officers. An analysis of the number of officers selected versus the minimum Army requirements for AAC critical skills indicates otherwise. There were 150 officers in the primary zone population for the FY98 Lieutenant Colonel Promotion Board. The selection board was given the requirement to select a minimum of 68 fully qualified AAC officers for promotion. The overall file quality of AAC officers in the primary zone resulted in the board selecting approximately 130 percent of minimum requirements.

Overall AAC Results

The FY98 Lieutenant Colonel Selection Board reviewed the files of 150 AAC officers in the primary zone. From this population, 85 were selected for promotion to lieutenant colonel. Additionally, the board selected one AAC officer from below the zone (0.6 percent), and three AAC officers (3.7 percent) from above the zone.

Statistics For Selected Officers

Functional Area	Primary Zone Considered	Primary Zone Selected	Primary Zone Percent
51	95	53	55.7%
53	23	18	78.3%
97	32	14	43.7%
TOTAL	150	85	56.6%

Promotion Trends

A review of those officers selected for promotion by the FY98 Lieutenant Colonel Board validated the following historical trends:

LTC = Army Command and General Staff College
+ Above Center of Mass (ACOM) Command
+ consistent ACOM performance

Army Command And General Staff College

Of those AAC officers in the primary zone who attended resident CGSC, 77.8 percent were selected for promotion. In addition, 26.3 percent of AAC officers in the primary zone who completed CGSC through nonresident studies were selected for promotion. In contrast, 7.3 percent of the officers in the primary zone did not complete CGSC (either resident or nonresident), and none of these officers were selected for promotion regardless of their overall performance.

Command

Company command reports appeared to be extremely important to board members. The majority of AAC officers selected for promotion received multiple ACOM Officer Evaluation Reports (OERs) as company commanders. These reports generally had either clear ACOM senior rater profiles and/or strong senior rater comments on potential. AAC officers with center of mass command OERs were usually not selected.

Consistent ACOM Performance

The last important trend was consistent ACOM performance throughout the officer's career. AAC officers selected for promotion generally had consistent ACOM OERs. Senior captains or majors with below center of mass evaluations were generally not selected for promotion.

Listed below are the FY98 AAC lieutenant colonel selectees.

LTC Promotion Selectees

BARBER WAYLAND P
BENTON JEFFERY A
BESCH THOMAS M

CAREER DEVELOPMENT UPDATE

BILLINGTON ROBERT
BRADSHAW JERRY L JR
BREFFEILH WILLIAM A
BRIDGES JON K
BRISTOW JAMES S
BROWN JOSEPH D
BROWNING JEFFREY W
BURNS RONALD R
CAMPBELL SCOTT A
CARLEY PATRICK J
CARROLL MAXWELL G
CHASTEEN GREGORY T
COFFMAN THOMAS
COMER ROBERT E
CUMMINGS TIMOTHY J
CURRY VIRGIL JR
DEVER DOUGLAS
DONOHUE MATTHEW C
DOYLE NORBERT S
EADY DONALD P
FINEMORE BRENT C
FINK JAMES V
FISCHER CLAUDIA J
FLOWERS KENNETH
GALLAGHER DANIEL J
GARMAN PATRICK J
GAZZANO LEE D
GIBSON DONALD V
GODDETTE TIMOTHY G
HALLENBECK PHILIP R
HARRINGTON GALE A
HAZELWOOD DONALD A
HILLIKER CRAIG W
HOLLINGSWORTH LARRY
HUGHES DANIEL P
JOHNSON AUDREY H
JONES RAYMOND D
JONES LUWANDA F
JOZWIAK EDWARD D
KELLEHER JOHN H
KIDD SCOTT R
KNUDSON OLE A
KOSTER JOHN L
KUNKEL GEORGE D
LANDERS MICHAEL D
LANGHAUSER CRAIG G
LANTZER PAULA K
LIPSIT CARL A
LITTLE CHRISTOPHER W
LOVETT ROBERT A
LUMB MARK D
MARSHALL JOHN C
MCGUIRE WILLIAM T
MCNERNEY CATHERINE
MILES RICHARD Z
MILLER CHRISTOPHER M
MILLER LAWRENCE C
MILLER SCOT C
MOLES JOSEPH B
MULLIN EDWARD L
NULK RAYMOND H
PARKER WILLIAM E
PARKER ERIC S
PENN BRADLEY E
PENNINGTON HOZIE W
PENNYCUICK RICHARD
PETERSON ALLEN L
PRENDERGAST TIMOTHY J
REESE TOBY D
ROSS CHRISTOPHER M
SHAFFER BRAD L
SHARKEY STEPHEN T
SHIRLEY RANDALL R
STOLESON KEVIN S
SWART JOHN J
SWEENEY JOSEPH F
TURNER LAWRENCE L
WALLACE STEPHEN M
WASSMUTH RICHARD J
WHEELER KENNETH A
WILLIAMS YANCEY R
WILLIAMS CURTIS R
WIRTH WALTER M
WOMACK JOHN H
YOUNG CAROL R

Cerutti Directs Acquisition Career Management Office

COL Edward A. Cerutti, former Commander, Defense Contract Management Command Raytheon, recently assumed new duties as Director of the Acquisition Career Management Office in the Office of the Assistant Secretary of the Army for Research, Development and Acquisition.

Backed by more than 24 years of active military service, Cerutti has served in a number of key positions, including assignment as a member of the Army Acquisition Corps Reengineering Team; Professor of Systems Acquisition Management at the Defense Systems Management College; and Commander of the 4th Battalion, 27th Field Artillery Regiment (Multiple Launch Rocket System) in Babenhausen, Germany.

A member of the Army Acquisition Corps, he holds a B.S. degree in engineering from the U.S. Military Academy, and M.S. and Ph.D. degrees in mechanical engineering from the University of Arizona. He has also completed the Field Artillery Basic and Advanced Courses, the Army Command and General Staff College, and the Army War College.

Listed among his awards and decorations are the Defense Superior Service Medal, the Meritorious Service Medal with four Oak Leaf Clusters, the Army Commendation Medal, and the Army Achievement Medal.

Personnel Changes In The Acquisition Management Branch

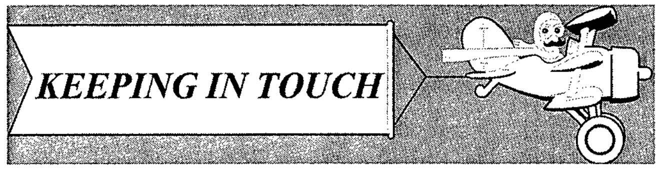
Six new officers recently assumed new assignments in the U.S. Total Army Personnel Command (PERSCOM).

LTC Mary Kaura, Chief, Acquisition Management Branch (AMB), has an extensive and varied acquisition background. She formerly served as the Product Manager for Battle Management and Command, Control, Communications, Computers, and Intelligence in the Theater Area Air Defense Project Office, Program Executive Office, Air and Missile Defense at Redstone, AL.

MAJ Paul Myrick, Functional Area (FA) 51 Lieutenant Colonels Assignments Officer, has served in a variety of acquisition positions. He recently completed a tour at the Pentagon as a Department of the Army Staff Officer, Program Executive Office, Tactical Missiles.

MAJ John Masterson, FA51 Majors Assignments Officer, has also served in a variety of acquisition positions. He recently completed a tour as the Assistant Product Manager for Materiel Change, Program Executive Office, Field Artillery at Picatinny, NJ.

MAJ James Norris, FAs 53 and 97 Majors Assignments Officer, is a recent graduate of the Army Command and General Staff College (CGSC). Prior to that, he was a contracting officer at Redstone, AL.



Remember to forward your new mailing address, work and home phone numbers, fax number, and e-mail address to your functional area assignment officer or acquisition specialist in the Acquisition Management Branch, PERSCOM.

MAJ Steve Decato, Officer Distribution Manager, recently completed the CGSC. Previously, he served at the Naval Postgraduate School in Monterey, CA.

CPT Tom Deakins, FAs 53 and 97 Captains Assignment Officer, joins PERSCOM after completing his first acquisition assignment as the Administrative Contracting Officer for the M1A2 Abrams Tank at the Lima Army Tank Plant in Lima, OH.

The accompanying chart provides current phone numbers and e-mail addresses for AMB personnel.

ACQUISITION MANAGEMENT BRANCH
E-Mail/Telephone Numbers

Chief, AMB LTC Mary Kaura	3131	KAURAM
COL Assignments MAJ Steve Leisenring	3090	LEISENRS
Distribution Manager MAJ Steve Decato	9383	DECATOS
LTC FA51 Assignments MAJ Paul Myrick	3129	MYRICKP
LTC FA53/97 Assignments MAJ Dwayne Green	3124	GREENDO
MAJ FA51 Assignments MAJ John Masterson	3128	MASTERSJ
MAJ FA53/97 Assignments MAJ James Norris	5479	NORRISJ
CPT FA51 Assignments CPT Eric Glenn	2800	GLENNE
CPT FA53/97 Assignments CPT Tom Deakins	1474	DEAKINST
Certification Manager (Vacant)	3130	

Advanced Civil Schooling Paula Bettes	2760	BETTESP
Boards/Schools Manager Rick Yager	3127	YAGERR
Military Technician Tony Staton	9354	STATON
Military Technician Latesha Holloman	2757	HOLLOMAL
Military Technician Tom Tabor	2758	TABORT
Management Assistant Veronica Gonzalez	3094	GONZALEV
FAS-Acq Career Field L,T,G Denny Barth	6137	BARTHD
FAS-Acq Career Field R,S Gail DiNicolantonio	3222	DINICOLG
Pers Mgt Spec/Training Sheran Jackson	2768	JACKSONS

Pers Mgt Spec/CPAC Gloria King	2762	KINGG
FAS (Vacant)		
FAS-Acq Career Field K,A Marietta Martin	9690	MARTINM2
FAS-Acq Career Field H,S Leon McCray	4267	MCCRAYL
FAS-Acq Career Field A,C Chris Vuxton	3215	VUXTONC
Pers Mgt Spec/Boards Cathy Johnston	2764	JOHNSTOC
Personnel Assistant Yvon Copes	2766	COPESY
Personnel Assistant Rosalyn Ford	2767	FORDR
Personnel Assistant Barbie Garner	2771	GARNERB

As of 15 Jul 98

AAC Automated Info Line	325-3411	**AMB E-Mail:**	**(USERID)@HOFFMAN.ARMY.MIL**
FAX	325-9001		
DSN	221-XXXX	PERSCOM Online:	WWW-PERSCOM.ARMY.MIL
CML	(703) 325-XXXX	AAC Home Page:	DACM.SARDA.ARMY.MIL

Commander
U.S. Total Army Personnel Command
ATTN: TAPC-OPB-E
200 Stovall Street
Alexandria, VA 22332-0400

Advanced Program Management Course Selection Criteria

The Acquisition Management Branch (AMB), U.S. Total Army Personnel Command (PERSCOM), is responsible for slating both military and civilian candidates for the Advanced Program Management Course (APMC). The slating methodology used for the APMC is described below.

MILITARY:

Priority 1: Officers selected by a Department of the Army (DA) central selection board to serve as a program, project, or product manager (PM) or acquisition commander (AC).
Priority 2: Officers on the alternate list for either PM or AC.
Priority 3: Officers selected for promotion to the rank of lieutenant colonel by the most recent promotion board.
Priority 4: Officers in the rank of lieutenant colonel who have not attended the course and are still eligible for selection as a PM or AC.
Priority 5: Officers who will be in the primary zone of consideration for promotion to lieutenant colonel and have completed the Army Command and General Staff College (CGSC).
Priority 6: Officers who have completed CGSC (either resident or nonresident) and are in a PCS status.
Priority 7: Officers whose command has requested that the officer attend this course and will release the officer to attend in a TDY and return status.

Officers in earlier year groups (YG) 83, 84, and 85 that have not completed CGSC (resident or nonresident) will not be slated to this course. It is important to remember that completion of the APMC is not a requirement for promotion to lieutenant colonel.

Officers in a nonselect status to the grade of lieutenant colonel will not be slated for APMC unless they are selected for promotion above the zone. Once an officer is selected for promotion to lieutenant colonel, they will be considered for APMC at the first available opportunity. Officers not selected for promotion to lieutenant colonel above the zone will not be slated to this course.

CIVILIAN:

Priority 1: Civilians selected by a DA Selection Board to serve as a PM.
Priority 2: Civilians selected as Deputy PMs.
Priority 3: Civilians currently serving in a Level III Program Management Acquisition Career Field position, but not certified at Level III.
Priority 4: Civilians on the alternate list for PM.
Priority 5: Civilians who have been selected for the Competitive Development Group.
Priority 6: Certified civilians currently serving in a Level III Program Management Acquisition Career Field position who have not attended the APMC and the supervisor wants the employee to receive the training.
Priority 7: All Army Acquisition Corps members.
Priority 8: Individuals who have been identified as Corps Eligible.
Priority 9: Army Acquisition Workforce, GS-13 and above.

More information about the APMC can be found on the Office of the Assistant Secretary of the Army for Research, Development and Acquisition and PERSCOM home pages.

Questions regarding the APMC should be directed to the AMB. The point of contact for officer inquiries is Rick Yager, DSN 221-3127 or (703) 325-3127, and the point of contact for civilians is Sheran Jackson, DSN 221-2768 or (703) 325-2768.

OPMS XXI Coding Changes Approved

On July 15, 1998, the Assistant Deputy Chief of Staff for Personnel approved release of the Officer Personnel Management System (OPMS) XXI Notification of Future Change (NOFC). The NOFC details changes to authorization documents and implements OPMS XXI. The NOFC should be applied to all Table of Distribution and Allowance and Modified Table of Organization and Equipment documents during the FY01 command plan change cycle that will be in effect no earlier than Oct. 1, 2000. The NOFC should also be applied to all currently valid Table of Organization and Equipment documents. The U.S. Total Army Personnel Command will recode personnel to meet the effective dates of the revised authorization documents.

The NOFC contains all elements of the single Functional Area (FA) 51 initiative for the Army Acquisition Corps (AAC). This initiative consolidates all AAC functional areas and areas of concentration (AOC) under FA51. The resulting FA51 will have five developmental CPT/MAJ AOC levels (A, C, R, S, and T) and one capstone LTC/COL AOC level (Z). Specifically, the NOFC:

- Retitles FA51 from "Research, Development and Acquisition" to "Acquisition."
- Revises the application of Skill Identifiers (SIs) 4M and 4Z. These SIs are no longer needed to identify AAC positions and personnel, but will be retained for use in identifying Army Medical Department (AMEDD) acquisition positions.
- Retitles AOC 51A from "Research and Development" to "Systems Development" (CPT/MAJ).
- Eliminates AOC 51B "Test and Evaluation" and transfers duties and tasks to AOC 51T "Test and Evaluation" (CPT/MAJ) and AOC 51Z "Acquisition" (LTC/COL).
- Retitles AOC 51C from "Combat Developments" to "Contracting and Industrial Management" and transfers combat development duties and tasks to AOC 51A "Systems Development" (CPT/MAJ) and AOC 51Z "Acquisition" (LTC/COL).
- Eliminates AOC 51D "Acquisition" and transfers duties and tasks to AOC 51Z "Acquisition" (LTC/COL).
- Eliminates AOC 53B (with SIs 4M/4Z) "Systems Automation Engineering" and AOC 53C "Systems Automation Acquisition" and transfers duties and tasks to AOC 51R "Systems Automation Acquisition and Engineering" (CPT/MAJ) and AOC 51Z "Acquisition" (LTC/COL).
- Eliminates FA97 and AOC 97A "Contracting and Industrial Management" and transfers duties and tasks to AOC 51C "Contracting and Industrial Management" (CPT/MAJ) and AOC 51Z "Acquisition" (LTC/COL).
- Establishes AOC 51R "Systems Automation Acquisition and Engineering" (CPT/MAJ).
- Establishes AOC 51S "Research and Engineering" (CPT/MAJ).
- Establishes AOC 51T "Test and Evaluation" (CPT/MAJ).
- Establishes AOC 51Z "Acquisition" (LTC/COL).

Assistance in recoding authorization documents is available from the Acquisition Career Management Office. The point of contact is LTC Mark Salesky, DSN 664-7146, (703) 604-7146.

From The Acquisition Reform Office...

SMDC Contracting Office Wins Hammer Award

The Army Space and Missile Defense Command (SMDC) is a Hammer Award winner. SMDC's Contracting and Acquisition Management Office was selected May 29, 1998, to receive the Vice President's Hammer Award for being the outstanding Army major command having the lowest overhead cost per dollar spent on a requirement. SMDC was also recognized for procurement process improvements resulting from creative and novel initiatives such as:

- Issuing credit cards to contracting personnel and other agencies requiring supplies and services up to $2,500. By using the credit card, agencies can now make purchases within the dollar threshold without going through their Contracts Office.
- Using oral proposals for various acquisitions. The use of oral proposals has reduced the evaluation process from months to days, and cut costs for paper supplies, reproduction services, and for storing and mailing paperwork.
- Using a three-step alternate source selection procedure, in lieu of best and final offers, to get a better end product in a competitive environment.
- Using the Small Business Innovation Research (SBIR) Program to integrate commercial technology into a military missile system in 4 of 28 awarded Phase II SBIR efforts. The SBIR Program was also used to achieve a new high by making Phase I awards in an average of 3 months from the date the solicitation closed. This exceeds the Department of Defense (DOD) lead time average of 6 months.

Captains Of Industry Executive Session

Then Acting Secretary of the Army Robert M. Walker and Chief of Staff GEN Dennis J. Reimer hosted the second Captains of Industry Executive Session on April 3, 1998. The purpose of the session was to continue dialogue and strengthen the partnership between the Army and industry. Corporate leaders and senior Army staff members participated in the session. Some of the issues were:

- Development of a DOD campaign plan to push privatization and outsourcing;
- Focusing science and technology on the Army After Next systems, identifying what industry and the Army are investing in research and development, and eliminating duplication;
- Continued promotion and support of dual technology initiatives that benefit both industry and the Army;
- Development of a transition plan for the "legacy systems" from Force XXI to the Army After Next;
- Stabilizing Army requirements to garner industry support; and
- Explaining the first digitized brigade and its capabilities to Congress to further advertise the significance of information dominance.

Industry executives indicated the session was extremely valuable in furthering their understanding of the Army's modernization vision and fiscal challenges, and in fostering the Army-industry partnership.

Modernization Through Spares Exhibit

As part of the Department of Defense Acquisition Reform Day activities on May 8, Army Materiel Command (AMC) project leaders provided displays of several systems that are candidates for the Modernization Through Spares (MTS) Program. Displays at the Pentagon included the AN/PPS-5 Ground Surveillance Radar, the Aviator's Night Vision Imaging System, and the Patriot PAC-2 Low Voltage Power Supply. Additional displays at HQ AMC included the AN/USQ-70 Position and Azimuth Determining System and the AN/PRD-12 Radio Direction Finding System, as well as the Patriot PAC-2 Low Voltage Power Supply. Explanatory materials accompanied each display, and project representatives explained both the technical aspects of the system and the employment of the MTS strategy to reduce support costs and enhance system capabilities.

Acquisition And Logistics Conference

The Department of the Army will hold a conference focusing on all acquisition and logistics initiatives aimed at reducing operations and support costs. The conference will be held Nov. 16-18, 1998, at the Marriott Wardman Park, 2660 Woodley Road NW, Washington, DC, 20008, and will offer the Army and its industry counterparts an opportunity to share ideas associated with the way our developmental and legacy systems are maintained. The Army hopes to improve the way it conducts business, ultimately providing the highest quality equipment to the warfighter into the next milennium.

Hosting the conference are Headquarters, Communications-Electronics Command; Program Executive Office (PEO), Intelligence, Electronic Warfare and Sensors; and PEO Command, Control, and Communications Systems. This conference is another step to enhance the relationship between government and industry.

For more conference information, visit the conference website at **http://www.mtsconf.sytexinc.com**.

NEWS BRIEFS

Soldier Enhancement Program Selections

In August 1997, the U.S. Army Training and Doctrine Command (TRADOC) System Manager-Soldier (TSM-S) solicited Soldier Enhancement Program (SEP) proposals for FY99. By the end of 1997, the TSM-S had received 147 separate proposals for consideration as SEP new start programs. SEP candidates must meet the following criteria:

- Be a soldier system item (worn, carried or consumed by the soldier for his or her individual use in a tactical environment);
- Be commercially available (off-the-shelf with little or no modification for field military use); and
- Satisfy an operational need or battlefield deficiency.

A proposal is a strong potential SEP candidate if it makes the soldier more effective or efficient on the battlefield; reduces the soldier's load (in either weight or bulk); or enhances lethality, survivability, command and control, sustainment, mobility, safety, training, or quality of life; or if soldiers are spending their own money to buy it.

In February 1998, the SEP executive council completed its annual SEP review and approved the following 13 programs as FY99 new starts: 40 mm (M203) Improved Munitions, M240 MG Dismount Kit, Medium Sniper Rifle System, Improved Entrenching Tool, Stab Protective Body Armor, Individual Camouflage System, Land Mine Probe, Thermal Camouflage Face Paint, Improved Pistol Holster/Harness for Soldiers, Cold Weather Fuel Handlers Glove, Tactical Search/Inspection Mirrors, Low Cost Absorbent/Moisture Transfer Undershirts, and Individual Riot Control Agent Neutralizer.

The SEP is NOT an incentive award program. No monetary awards are given for proposals that are adopted for use and result in a cost saving to the government.

Additional information on the SEP may be obtained from the TRADOC System Manager-Soldier, ATTN: ATZB-TS, Fort Benning, GA 31905-5000, or by calling DSN 835-1189 or (706) 545-1189, or by faxing a request to DSN 835-1377 or (706) 545-1377.

BOOKS

A Guide To The Project Management Body Of Knowledge

Project Management Institute, 1996.

Reviewed by LTC Kenneth H. Rose (USA, Ret.), a project manager with the Waste Policy Institute in San Antonio, TX, and a former member of the Army Acquisition Corps.

No single, definitive text exists that universally codifies the practice of project management. But *A Guide to the Project Management Body of Knowledge* published by the Project Management Institute comes close.

This book is a repository of proven, traditional practices that are generally accepted by the project management community. Described techniques enjoy widespread consensus but, as pointed out in the text, do not stand alone as rigid requirements to be uniformly applied to each and every project. The book—*PMBOK Guide*, for short—comprises a subset of the inclusive professional body of knowledge from which project managers or others may select tools appropriate for their needs.

Prepared by the Project Management Institute's Standards Committee, the current volume is a 1996 revision of the 1987 original. It describes a growing, evolving body of knowledge and, accordingly, is scheduled for revision in 1999. It falls neatly into two major parts: a section with three chapters that describes the project management framework, and a section with nine chapters that individually addresses the central knowledge areas of project management. Concluding sections include appendices that provide ancillary information, and an extensive glossary and an index.

The introduction, Chapter 1, defines a project as "a temporary endeavor undertaken to create a unique product or service." This is a new definition intended to include all things that *are* projects and exclude all that *are not*. The word "temporary" does not indicate that projects are necessarily of short duration; it means that projects have definite beginnings and definite endings. Activities that seem to come to an end, only to continue under newly established goals (much like the first movement of Beethoven's Fifth Symphony, for the musicians among us), are probably not projects. A true project ceases when it achieves its declared goals. The project team then disbands.

A *program* is defined as "a group of projects managed in a coordinated way to obtain benefits not available from managing them independently." This difference and the relationship between projects and programs is not a matter of universal agreement. It is a matter to be resolved by organizations according to their understanding and needs.

Project management goes beyond the day-to-day activities of a project. This broader context of project management is the focus of Chapter 2, which begins with a discussion of project life cycle using the model in DOD 5000.2 as an example. A follow-on discussion addresses project stakeholders, organizational issues and options, general management skills, and socioeconomic influences. The brief paragraph on leadership may provide an opportunity for expansion in the 1999 revision.

The framework section closes with a discussion of project management processes in Chapter 3. This chapter establishes the foundation that project management is an integrated endeavor in which actions in one area affect other, interlinked areas, sometimes in subtle, nonobvious ways. Project processes exist in five groups: initiating, planning, executing, controlling, and closing. These process groups are linked by their results—the output of one process serves as input to another. Superficially, the links appear to be serial and sequential. In application, process groups are more a network exhibiting a many-to-many relationship among the nodes. Several helpful network diagrams include references to specific paragraphs in the book that discuss the named activities. A final warning reminds readers that all projects are not alike, that processes must be customized considering the situation at hand.

Recognizing this integrated aspect of project management, the knowledge area section opens with a chapter dedicated to integration, a knowledge area that was added in the 1996 revision. The nine chapters of this section share a common format. Each includes a number of topic paragraphs that are divided into three subparagraphs: inputs, tools and techniques, and outputs. This organization is more than a matter of convenience; it reflects directly back to the concept of integrated processes, making the output-input link explicit.

The nine knowledge area chapters are the how-to substance of the *PMBOK Guide*. Individual chapters address integration, scope, time, cost, quality, human resources, communications, risk management, and procurement. Each chapter consists of clear, lucid text organized in a hierarchical format similar to a work breakdown structure.

Each knowledge area chapter is densely packed with essential information. The great benefit of this book is that it offers so much in only 176 pages. Still, some readers may look for more. The paragraph on team development in Chapter 9 does not seem to do justice to the central issue of contemporary project management. This may be another opportunity for expansion in the next revision.

The seven appendices provide related information, including endnotes for chapters and a list of professional organizations related to project management. The glossary includes an extensive list of acronyms and defined terms.

Project management encompasses a maturing body of knowledge. As challenges are overcome, new information becomes available to those who must tread similar ground. *A Guide to the Project Management Body of Knowledge* is probably the resource currently available for such a journey. Certainly it is one to use now, and one to grow with in the future.

CONFERENCES

AMCOM Hosts Data Compression Workshop

In collaboration with the Army Research Laboratory and the Army Research Office, the U.S. Army Aviation and Missile Command (AMCOM) will host a data compression workshop in the Sparkman Auditorium at Redstone Arsenal, AL, Dec. 3-4, 1998. Titled *Compression Processing Techniques for Missile Guidance Data Links*, the workshop has two objectives. The first is to assess data compression techniques (military and commercial) for missile guidance applications including the compatibility of the techniques with DOD digitization initiatives. The second objective is to provide a focus for Defense Advanced Research Projects Agency investments in formation technology and signal processor development.

For more information, contact Angie Cornelius at (256) 876-5427 or at **angie@smaplab.ri.vah.edu**.

ARMY RD&A WRITER'S GUIDELINES

About *Army RD&A*

Army RD&A is a bimonthly professional development magazine published by the Office of the Assistant Secretary of the Army (Research, Development and Acquisition). The address for the Editorial Office is: DEPARTMENT OF THE ARMY, ARMY RD&A, 9900 BELVOIR RD, SUITE 101, FT BELVOIR VA 22060-5567. Phone numbers and e-mail addresses for the editorial staff are as follows:

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Purpose

To instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the Army Acquisition Workforce.

Subject Matter

Subjects may include, but are not restricted to, professional development of the Army's Acquisition Workforce, RD&A program accomplishments, technology developments, policy guidance, information technology, and acquisition reform initiatives. Articles containing footnotes are not acceptable. Acronyms used in manuscripts and with photos must be kept to a minimum and must be defined on first reference.

Length of Articles

Articles should be approximately 1,500 to 1,600 words in length. This equates to approximately 8 double-spaced typed pages, using a 20-line page. Do not submit articles in a layout format.

Photos and Illustrations

A maximum of 3 photos or illustrations, or a combination of both, may accompany each article. Photos may be black and white or color. **Illustrations must be black and white, in PowerPoint, and must not contain any shading, screens or tints**. Not all photos and/or illustrations may be used and they will not be returned unless requested.

Biographical Sketch

Include a short biographical sketch of the author/s. This should include the author's educational background and current position.

Clearance

All articles must be cleared by the author's security/OPSEC office and public affairs office prior to submission. The cover letter accompanying the article must state that these clearances have been obtained and that the article has command approval for open publication.

Offices and individuals submitting articles that report Army cost savings must be prepared to quickly provide detailed documentation upon request that (1) verifies the cost savings; and (2) shows where the savings were reinvested. Organizations should be prepared to defend these monies in the event higher headquarters have a higher priority use for these savings. All Army RD&A *articles are cleared through SARD-ZAC. SARD-ZAC will clear all articles reporting cost savings through SARD-RI. Questions regarding this guideline can be directed to SARD-ZAC, Acquisition Career Management Office, (703)604-7103, DSN 664-7103.*

Submission Dates

Issue	*Author's Deadline*
January-February	15 October
March-April	15 December
May-June	15 February
July-August	15 April
September-October	15 June
November-December	15 August

Submission Procedures

Article manuscripts (in MS Word) and illustrations (in PowerPoint) may be submitted via e-mail to **bleicheh@aaesa.belvoir.army.mil**, or on a 3 1/2-inch floppy disk via U.S. mail to DEPARTMENT OF THE ARMY, ARMY RD&A, 9900 BELVOIR RD, SUITE 101, FT BELVOIR VA 22060-5567. Photos may be e-mailed *for review purposes only*, but glossy prints must be sent via the U.S. mail. All submissions must include the author's mailing address, office phone number (DSN and commercial), and a typed, self-adhesive return address label.

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PERIODICALS

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